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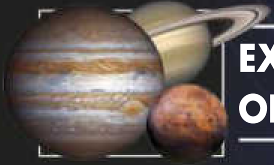
Sky at Night MAGAZINE

YEARBOOK 2016

Your guide to the best stargazing every month

12 MONTHLY STAR CHARTS

A FULL YEAR OF OBSERVING TIPS AND PROJECTS



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WELCOME

With occultations, conjunctions, comet apparitions and a planetary transit of the Sun, 2016 promises much for astronomers, and here in our comprehensive annual guide to the night sky we've got all the information amateur astronomers need to see constellations, planets and deep-sky objects all year long.

Whether you want to enjoy the constellations with the naked eye, home in on the most intriguing stars or use your telescope to enjoy the planets and beyond, there will be something here for you.

The *Yearbook 2016* is designed to be used as your guide to viewing and photographing the wonders of the cosmos in the 12 months ahead. Our monthly guides include a detailed chart of the night sky showing all the constellations visible from the UK, along with guidance on finding targets with the help of nearby stars and extra diagrams to highlight the most interesting sights.

We've also included four special sections on outstanding objects visible in each of the seasons, with details of how they'll look to the naked eye, with binoculars, and with a telescope. Plus there are three long-term imaging projects to get stuck in to, giving astrophotographers the chance to record the changing nature of our cosmos, including suggested settings to use as a starting point and presentation ideas. There's also inspiration from the Insight Astronomy Photographer of the Year competition.

> “We've got all the information amateur astronomers need to see constellations, planets and deep-sky objects all year long”

I hope the *Yearbook 2016* keeps you looking up throughout the year. The only other thing you need are clear skies!

Chris Bramley
Editor

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ISTOCK

VISUAL OBSERVING GUIDE

THE PLANETS

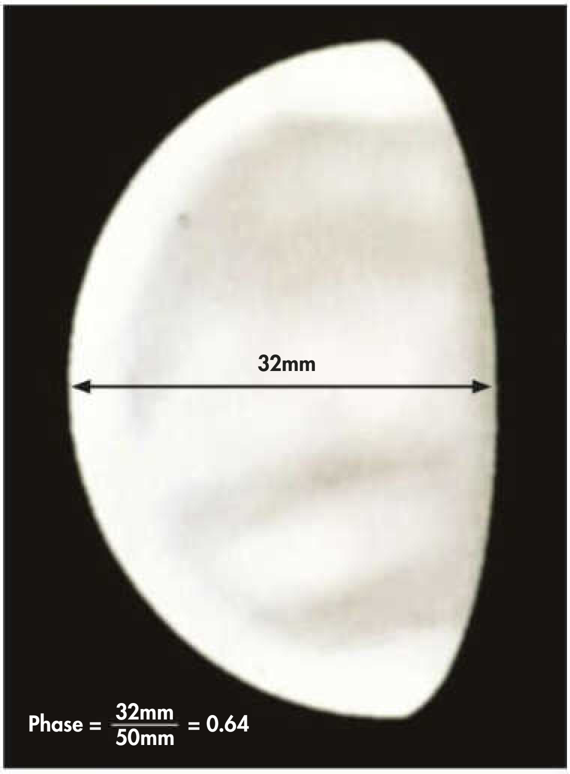
Paul Abel's guide to the closer planets shows how to get the best views and sketch the results

There was a time before webcams and CCDs when photographic film had a resolution lower than that of the human eye. During this era, the only reliable tools astronomers could rely upon were their own vision and a pencil, but even with these limited resources some startling discoveries were made. The astronomers of this era seem to be like great explorers venturing out into a vast and complex cosmos, their drawings and observations rather like postcards from alien frontiers.

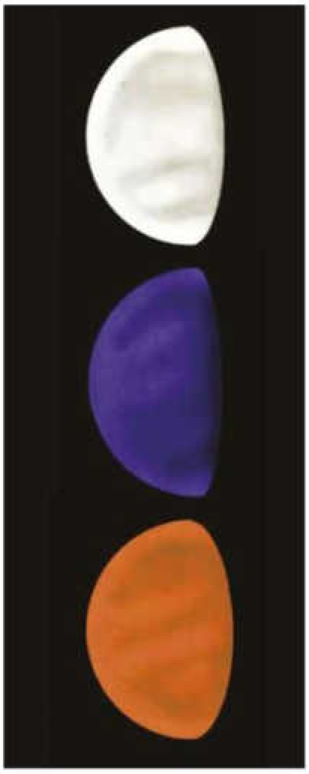
Today, the sensitivity and size of imaging equipment has improved immeasurably. Yet even in the 21st century, there are still areas of amateur astronomy in which visual observers can make valuable contributions. Visual observers need many specialist techniques to obtain reliable results that can go into the scientific record and here we introduce some of these observing skills with the aim of making you a better astronomer. We're going to look at the most rewarding planets for study: Venus, Mars, Jupiter and Saturn. ▸

ISTOCK, PAUL ABEL X 3

VENUS



▲ Determining the phase of Venus from your drawing is easy. Simply measure the widest horizontal distance from the limb to the terminator. Here it's 32mm, and so for a 50mm sketching circle the phase is 32/50, which is 64 per cent



▲ The Schröter effect is easily seen through a blue filter (middle) in these three views drawn on the same night

VENUS CAN BE a challenging object for visual observers, yet in the 1960s it was such astronomers who helped to establish that the planet's clouds have a three-day rotation period. With Venus, a visual observer's main objectives are to obtain disc drawings that correctly show the phase and to record elusive cloud markings.

A cursory telescopic view of Venus will reveal a bright white disc with a phase. The bright cusp caps covering the poles may be glimpsed, but that will probably be the only detail. Don't be put off, though: with time and patience subtle cloud markings come into view. The first thing to do is to find the correct magnification: one that gives a reasonable disc size and is suitable for the seeing conditions. I find 130-160x to be about right. Venus is also best observed in bright skies, as this reduces the glare from the disc.

As with all planets, don't expect to see all the fine details at once – you will need to engage with your visual system (one of the most remarkable adaptive optics kits on Earth). Ask yourself what you can see on the disc and slowly your eyes will respond. Spend about 15 minutes looking at the planet's disc before you start drawing.

To sketch Venus you'll need a circle 50mm in diameter. Draw in the phase and then, with a 2B pencil, gently shade in the subtle cloud markings. Eyepiece filters are a great help as they allow you to see into different depths of the atmosphere. Red and blue filters help to enhance cloud markings, while a yellow filter will bring out the polar collars.

The Schröter effect

Look at Venus when it's predicted to be at half phase and you'll notice that the phase is actually slightly less than half. This is the Schröter effect, where Venus's observed phase is always less than the theoretical one, and it is particularly prominent in a blue filter.

The phenomenon was first recorded by Johann Schröter in the 1790s, and is due to light being scattered in the thick Venusian atmosphere. You can record it for yourself: on your drawing: simply measure the distance (in mm) with a ruler from the limb to the terminator and divide this distance by 50 to get the observed phase of Venus. Do this for all of your drawings and you can plot the decreasing phase against time on a graph and show how the effect changes over the course of an elongation.

KEEPING A LOG BOOK

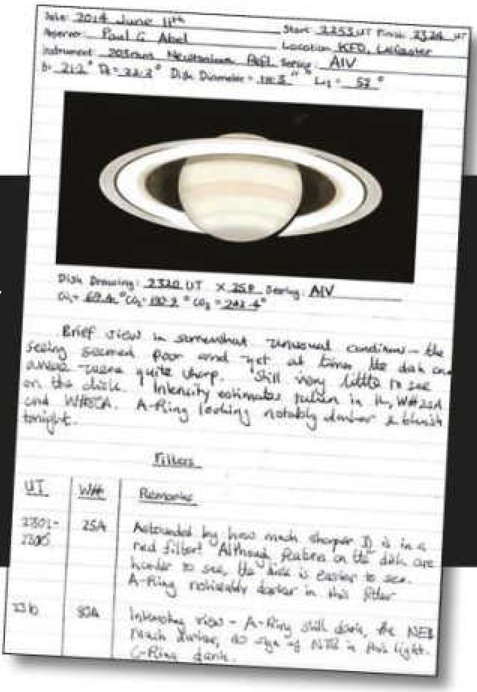
Keeping a log book is an essential skill for any visual observer. It will keep your observations in a logical structure and you'll be able to look back and see how your drawing skills have developed. Your log book should be a sturdy bound notebook, and every observation should include the following information:

THE DATE OF OBSERVATION

THE TIME, always in UT

THE TELESCOPE AND MAGNIFICATION, along with the details of any filters used

THE SEEING CONDITIONS, recorded using the Antoniadi scale, which runs in Roman numerals from I to V; I is perfect seeing and V is a very poor unfocused image



Date: 2014 June 11th
Observer: Paul G Abel
Start: 2253 UT Finish: 2324 UT
Instrument: 203mm Newtonian Refl. Seeing: AIV
Location: KFD, Leicester
B = 21.2° [illegible] = 24.2° Disk Diameter = 18.3" L1 = 57°

Disk Drawing: 2320 UT ×258 Seeing: AIV
CM1 = 62.4° CM2 = 180.2° CM3 = 241.4°

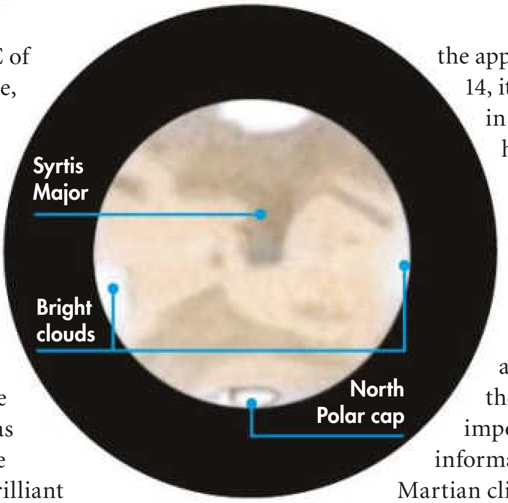
Brief view in somewhat unusual conditions – the seeing seemed poor and yet at times the disk and [illegible] were quite sharp. Still very little to see on the disk. Intensity estimates taken in the W#25A and W#80A. A-Ring looking notably darker & bluish tonight.

Filters

UT	W#	Remarks
2301-2305	25A	Astounded by how much sharper it is in a red filter! Although features on the disk are harder to see, the disk is easier to see. A-Ring noticeably darker in this filter
2310	80A	Interesting view – A-Ring still dark, the NEB much darker, [illegible] of NTB in this light. C-Ring dark.

► A page from the author's Saturn log book shows observation details, a drawing and some filter remarks

MARS



▲ **Use high magnifications to reveal dark albedo features like the Syrtis Major**

THE OCHRE DISC of Mars is full of subtle, slowly changing features. Mars is a world of vast volcanoes, continent-sized canyons and majestic deserts. It's not uncommon for fogs to collect in the basins such as Hellas and Argyre, and the volcanoes attract brilliant clouds at their summits. Martian meteorology changes over the course of a few hours, and it can all be recorded and studied visually.

The well-defined Martian seasons produce different phenomena. During the apparition of 2013-14, it was springtime in the northern hemisphere, and the brilliant north polar cap shrank dramatically as it sublimated away. Recording the retreat and advance of the polar caps is important as it reveals information about the Martian climate.

The dust-storm season occurs during spring and summer in the southern hemisphere. Telescopically, these storms resemble small orange clouds, and they can engulf the entire planet. It may take many months for the dust to clear and afterwards there may be changes to the dark albedo features. You can track the progress of large dust storms, recording their size and changes to local surroundings. A green filter helps enhance them.

Mars tolerates high magnification well because red light is less affected by Earth's turbulent atmosphere. At powers of 300x, dark albedo features like the Syrtis Major will show a multitude of subtle structure.

Drawing Mars requires some patience. You can't spend any longer than 15 minutes doing so as Mars's rotation will have moved the features away from where you've placed them in the drawing. Sketch the phase first if it is present, then the polar caps. Spend seven minutes putting down the obvious features and use the remaining time to put in any bright clouds you can see. A blue Wratten No. 80A filter helps enhance white clouds. Aim to make two to three drawings over a night to show how the clouds change.

JUPITER

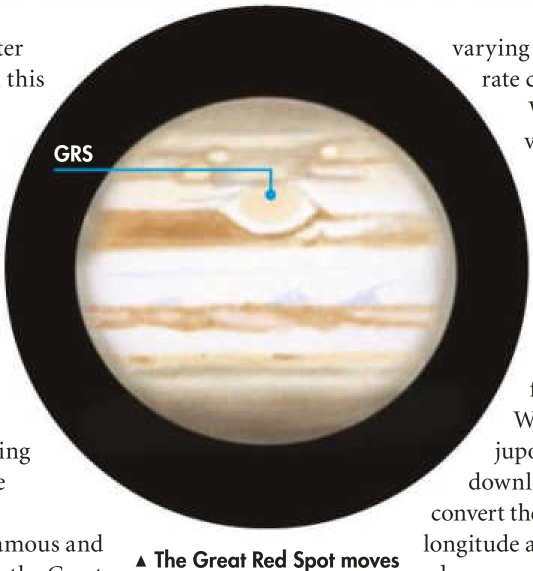
THE RESTLESS CLOUDS of Jupiter have generated plenty of work for visual observers for hundreds of years. Through a telescope, this gas giant is differentiated into darker belts and brighter zones. Powerful jet streams carry large storms along, presenting us with an ever-changing cloudscape.

Jupiter has a large disc and magnifications of 160x or more are sufficient to reveal a lot of fine detail. A red filter helps to enhance bluer features like festoons along the equator. Conversely a blue filter helps to enhance redder objects like the belts and the Great Red Spot. A yellow filter gives good all-round contrast.

It takes practice to record Jupiter correctly, but doing so will really hone your observational skills. A Jupiter drawing requires the correct blank: this planet is appreciably flattened due to its rapid rotation, so the standard blank is 64mm wide but only 60mm high.

PAUL ABEL, PAUL WHITFIELD

Like Mars, Jupiter rotates quickly; in this case you have 10 minutes to make your sketch. First draw the main belts and large storms, recording the ones near the preceding edge first as these will vanish soonest. Spend the remaining time adding in the finer details.

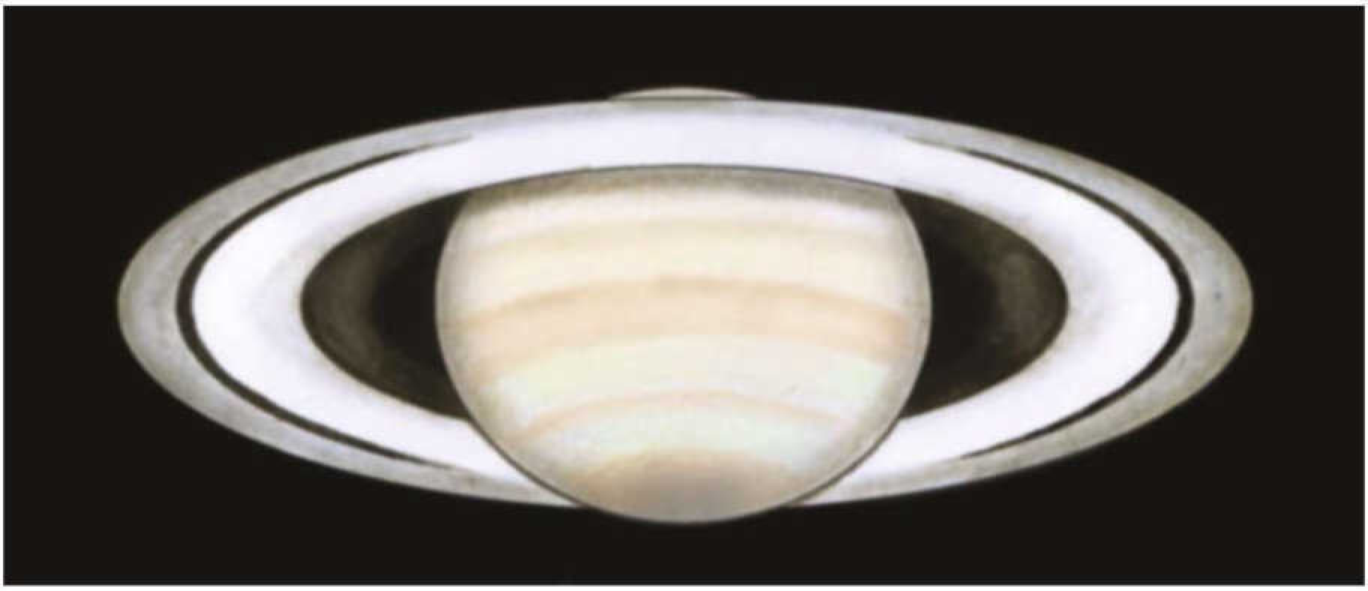


▲ **The Great Red Spot moves in longitude but is held at a fixed latitude of 22°S**

Jupiter's most famous and persistent storm is the Great Red Spot, a vast hurricane situated in Jupiter's South Tropical Zone. Visible to a 5-inch scope, the Great Red Spot drifts in longitude at varying speeds; this drift rate can be measured.

When the storm is visible, watch as it moves towards the central meridian. When you think its centre is on the meridian, record the time. Use freeware software WinJUPOS (www.jupos.org/gh/download.htm) to convert the time into longitude and repeat this whenever you observe the Great Red Spot. You can plot the resulting longitudes against time and look at how quickly the spot is moving in Jupiter's atmosphere.

SATURN



▲ One of the author's Saturn sketches; the white storms that occur in the equatorial region are best seen with a blue Wratten No. 80A filter

IT IS OFTEN said that majestic Saturn is a 'quieter' Jupiter. The belts and zones of Saturn's atmosphere are less well defined, but the storms that this planet can produce are even more ferocious.

Watching and charting storm activity is one of the main tasks for visual observers of Saturn. Storms are seasonal, occurring every 30 years, and usually take the form of a large white oval on Saturn's equator. The next outbreak is due near 2020.

Recently Saturn has produced other storms: quite unexpectedly in late 2010 a large storm erupted in the planet's northern hemisphere, lasting into 2011. This powerful storm churned up the North Tropical Zone, reminding us of the need for a constant vigil if we're to catch the next outbreak.

To really view Saturn, you'll need to use a power of 160x or more; 250x is a good all-round magnification. Drawing Saturn requires five accurately placed ellipses – so don't try to do it free-hand, use a carefully produced blank.

Saturn is also a quick spinner, so spend about eight minutes drawing in the main features on the disc and the rings, and use the final four minutes to finish the fine details such as the fainter belts and shadows. Filters work well for Saturn: yellow enhances the contrast between belts and zones, while light blue helps to emphasise redder features. Also watch out for a bi-coloured aspect of Saturn's rings: occasionally Saturn's outermost ring, the A-Ring, appears brighter in a blue filter than in a red one. Although rare, this phenomenon has been reported by visual observers and is worth keeping an eye out for.

ABOUT THE WRITER

Dr Paul Abel is an astronomer based at the University of Leicester. You can listen to him on our Virtual Planetarium each month.

TOOLS OF THE TRADE

EYEPIECES

A selection of medium- and high-power eyepieces, giving a range of magnifications to suit your seeing conditions. A useful range is 160-190x for low power, 200-250x for medium power and 300x-plus for high power.

FILTERS

These help to enhance different features on planetary discs. Red, blue and yellow filters are invaluable.

PENCILS

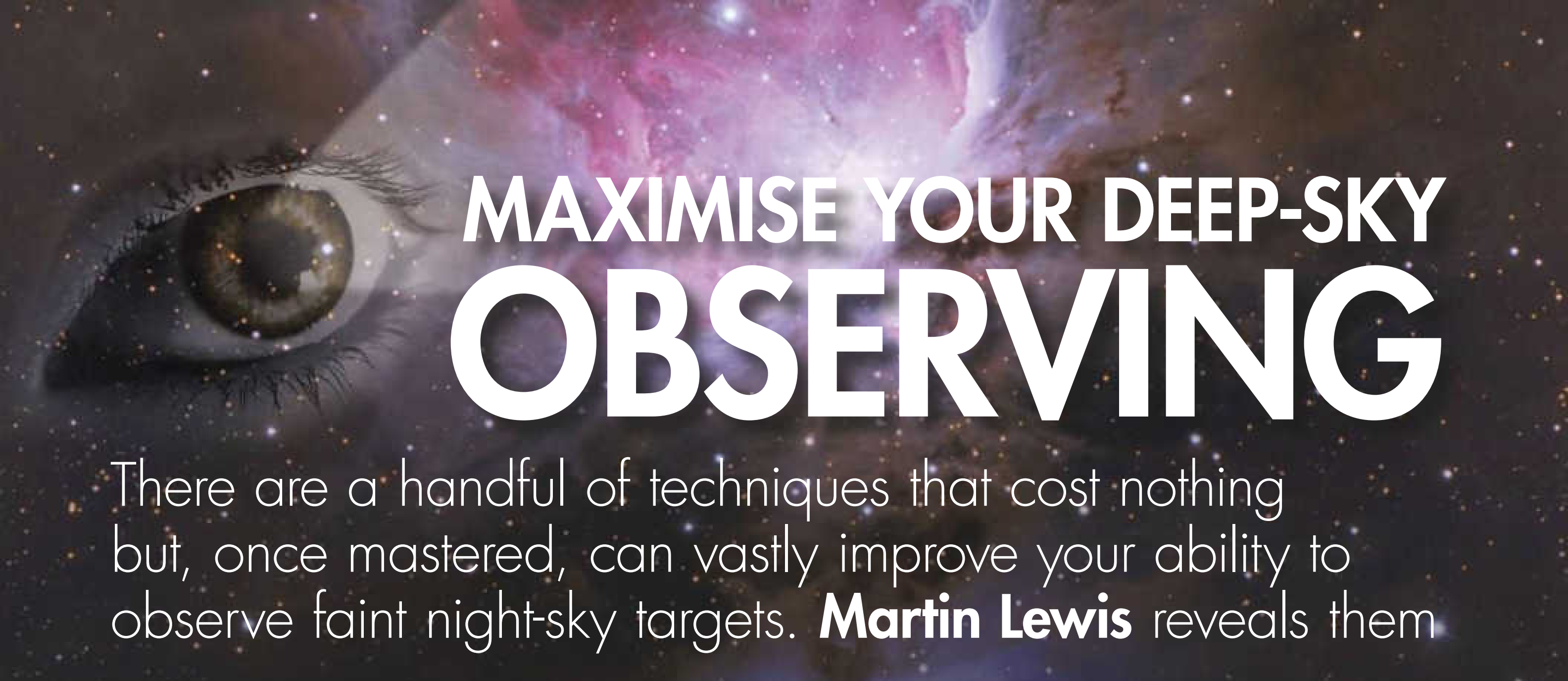
Some planetary features are more subtle than others, so you'll need a range of pencils from HB to 6B to capture as many as possible.

RED LIGHT

White light destroys night vision, so always use a red light to draw.

WINJUPOS

This essential free software (www.jupos.org/gh/download.htm) displays the features present on Jupiter or Saturn's disc at any date and time, and gives you the planetary longitudes for both gas giants so you can record the location of details. It is especially helpful as these planets have three systems of longitude due to their different bands of rotation.



MAXIMISE YOUR DEEP-SKY OBSERVING

There are a handful of techniques that cost nothing but, once mastered, can vastly improve your ability to observe faint night-sky targets. **Martin Lewis** reveals them

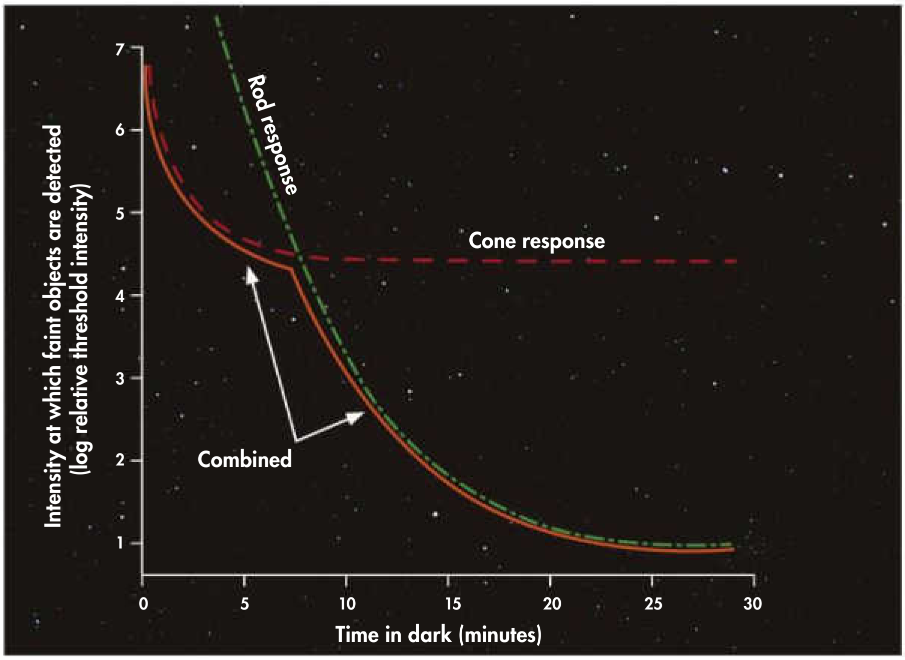
Much of the appeal of astronomy comes from the visual appreciation of celestial objects, whether they are seen directly through the eyepiece or indirectly in images taken by space telescopes. But when it comes to direct observing, there are a number of things you can do to get better views. Understanding how the eye and brain work best together is one; developing special observing techniques another. Over the next few pages, we're going to look at some of these tried and tested methods, which can help you to spot faint objects and examine low-contrast detail.

ABOUT THE WRITER

Martin Lewis is a keen astronomer. As a regular *First Light* reviewer, he has in-depth knowledge of observing with all sorts of equipment.

DARK **ADAPTATION**

Allowing adequate time for your vision to adjust to darkness can deliver huge gains



DARK ADAPTATION ALLOWS our eyes to see more clearly in conditions of low light. This key technique relies on two changes in the eye, one fast and one slow.

The rapid change is where the eye's pupil dilates to its maximum diameter, allowing more light to reach the retina where it triggers nerve impulses. For the naked eye, dilation increases the eye's light gathering capability by about 16 times. When using a telescope, the pupil's maximum dilated size determines its lowest useful magnification as well as an object's maximum surface brightness. So for high and medium magnifications, where the eyepiece exit pupil is much smaller than the dilated pupil, dilation gives little benefit.

The second slower but potentially much larger improvement in eye sensitivity happens thanks to chemical changes that occur in the retina in the absence of light. Such changes can increase its sensitivity by an amazing one million times.

The retina contains two kinds of light-sensitive cells: rods and cones. Cones can detect colour and brightness and are generally used for daytime vision. Rods can potentially be much more sensitive but don't detect colour, and because their density is lower their resolution is limited. When you go from a bright environment to a dark one the retina's sensitivity begins to improve immediately. To start with, the colour-sensitive cones adapt most quickly and are the more sensitive, but after about 10 minutes their improvement tails off and the rods take over, reaching maximum sensitivity after about 30 minutes.

There's a reason astronomers use dim red lights to work at night. To read maps and equipment settings in the dark, you need to use the better resolution of the colour-sensitive cones rather than the lower-resolution rods. At the red end of the spectrum the rod and cone sensitivities almost match, allowing for high-resolution colour vision from the cone cells with minimal excitation of the rods, so preserving dark adaption.

ISTOCK, GRAPH BY PAUL WOTTON/REF: MARTIN LEWIS, ROCHUS HESS/CCDGUIDE.COM

USING **HIGH MAGNIFICATION**

Knowing when to boost the magnification of your setup will help to reveal hidden detail

Complex bodies like the Whirlpool Galaxy require a range of magnifications to explore fully

ONE MIGHT IMAGINE that using lower eyepiece magnifications would make detail in deep-sky objects easier to see by increasing the object's overall surface brightness. However, this is generally not the case: higher magnifications usually allow you to see more detail.

As you increase your magnification two changes occur that affect the visibility of low-brightness and low-contrast detail in deep-sky objects. The most obvious change is that the detail gets larger, clearly making it more visible. The second change is that both the background brightness and the object brightness fall. Even though the relative contrast stays the same, this decrease in brightness makes things harder to see. Up to an optimum magnification, the benefit of increased size more than outweighs the fall in brightness: increasing magnification allows you to see more detail. Beyond the optimum, the benefits of further boosting the size tail off and things then become harder to see because the falling brightness wins out.

The brain and eye work best when the detail you want to see appears 1-2° across. So experiment at the eyepiece, increasing the magnification until image details are about this apparent size. In a large complex object like the Orion Nebula or the Whirlpool Galaxy, where there are a range of different detail sizes, brightnesses and contrasts, you will probably find that you need to use a range of different magnifications to pull out all the different detail present – lower magnifications for the really large features and higher magnification for the finer detail.

Targets with high surface brightness and fine detail, such as the Eskimo Nebula or the Cat's Eye Nebula, can benefit from really bumping up the magnification to see all the detail present, but do pick a night where the atmosphere is steady. High powers can also be used to advantage to enable you to see the faintest stars in globular clusters or to detect small faint galaxies. Such objects at the threshold of vision are regarded as point sources by the eye and brain. This means that increasing the magnification leaves them unaffected but darkens the sky, so increase the effective contrast and allow them to pop into view.

USING **LOW MAGNIFICATION**

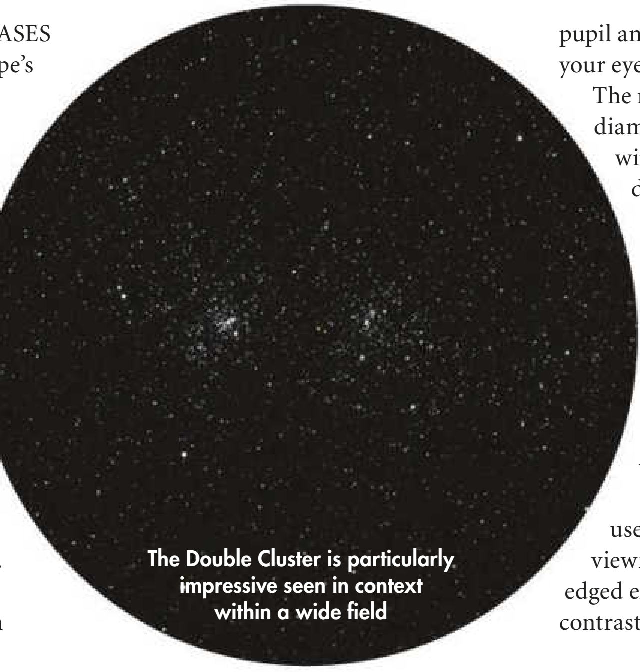
Increasing the amount of sky visible in the eyepiece can have some surprising benefits

LOWER MAGNIFICATION INCREASES the area of sky visible in your telescope's eyepiece. This allows some of the larger deep-sky objects, such as the Andromeda Galaxy or the Double Cluster in Perseus, to look better by giving them a surrounding frame of darker background sky.

Dropping the eyepiece power also has the effect of increasing an object's surface brightness by concentrating its light over a smaller angular area. As the power is progressively dropped the diameter of the bundle of light leaving the eyepiece – the so-called 'exit pupil' – also increases. Eventually a limit is reached where the exit pupil is larger than your own pupil and not all the light can enter your eye.

The magnification that matches the diameter of the eyepiece exit pupil with the diameter of your fully dilated pupil is your telescope's lowest useful magnification. At this magnification the surface brightness of a deep-sky object reaches a maximum. Some objects, such as the Orion Nebula, may be bright enough to excite some of the cone cells in your eye, which may allow you to see some faint colour.

Lower powers, combined with the use of movement, can also help with viewing the extremities of very soft-edged extended objects by increasing the contrast gradient at those edges. ▸



The Double Cluster is particularly impressive seen in context within a wide field

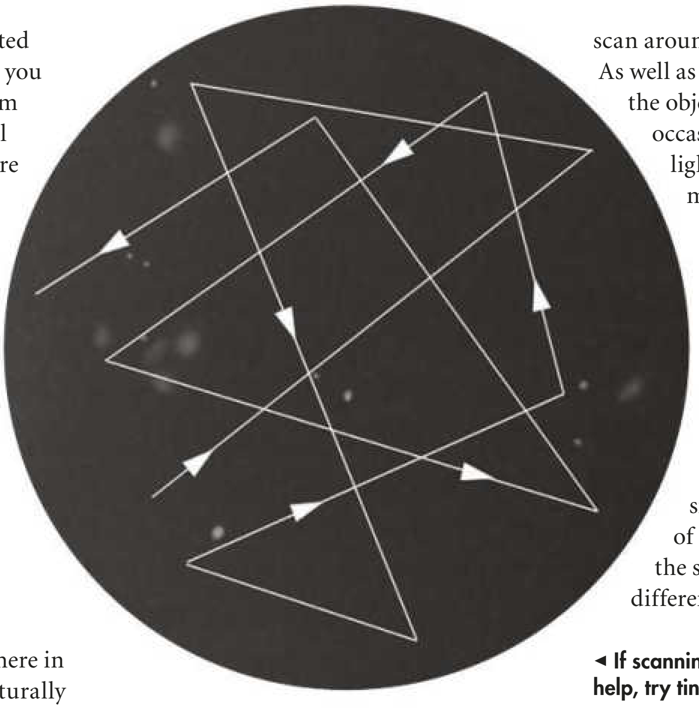
USING **MOVEMENT**

Scan around the field of view to stop your brain from mistaking dim targets as 'noise'

WHEN YOUR FULLY dark-adapted eyes are working in very low light you will probably notice lots of random flashes, sparkles and other general background noise. If you then stare fixedly through the eyepiece, even using averted vision, any low-contrast object will fade from view. This is because the eye and brain will just treat the object as part of this background noise. Scan your eye around the field, however, and you stand a much better chance of spotting your target. When the retina is exposed to a dim, low-contrast pattern that is moving, the brain recognises it as something real rather than background noise.

To detect a faint galaxy somewhere in the eyepiece, allow your eye to naturally scan around the field of view at random. As well as creating some movement of the object on the retina, the image will occasionally land on the retina's more light-sensitive peripheral parts, making the galaxy briefly visible.

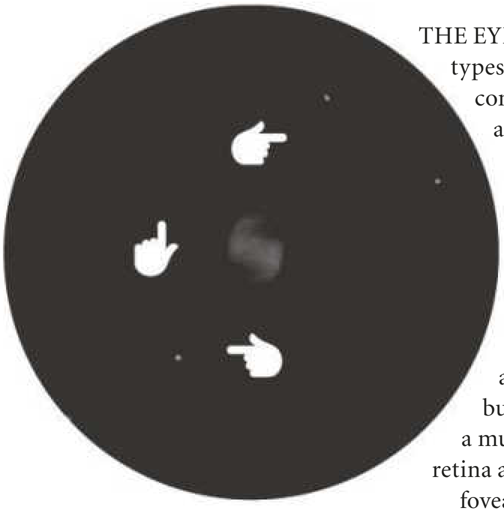
Even with the eye scanning around the field, the brain tends to ignore spread-out areas with a low-contrast gradient. If these areas are moved relative to the darker edges of the eyepiece field, however, they then become much easier to see. Try using small back and forth movements of the telescope or repeatedly tap the side of the eyepiece and see the difference it makes.



◂ If scanning the eye around the field doesn't help, try tiny movements of the telescope

AVERTED **VISION**

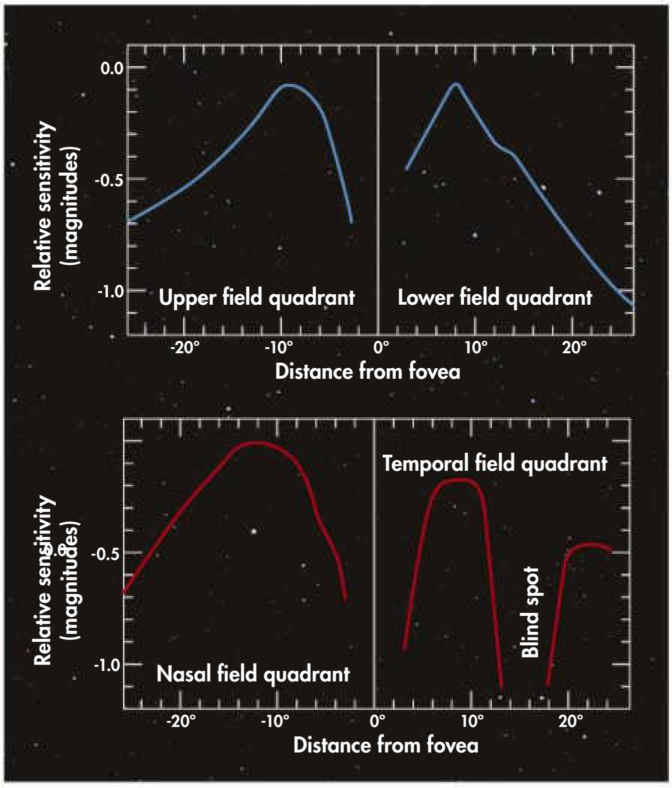
Looking away from your target can give you a better view than a direct stare



▴ Averted vision involves looking 10° to the side of your target – just make sure you avoid the blind spot

THE EYE'S RETINA has two types of light receptor cells: cones and rods. Cones allow us to see colour and detail, and have a very high density at the centre of your retina, in the fovea, which creates the centre of your vision. The colour-blind rods are more numerous but are spread out over a much larger area of the retina and away from the fovea. In a fully dark-adapted eye the rods are far better than cones at detecting faint light, and it is these cells you generally use at night.

The charts on the right show that the sensitivity of the dark-adapted eye peaks at about 8-15° from the fovea, where the rod density is the highest. This suggests a useful technique of pointing your vision about 10° to one side of an object of interest but keeping your attention and interest directed on it. This technique, called averted vision, may seem a bit unnatural to start with, but you will soon get the hang of it. And it is worth doing so – it can dramatically improve your ability to see faint objects and dim details. For best results keep your eye moving, placing the object above or below the centre of your vision or on the nose side of your fovea. Do, however, avoid the opposite side to this, where the blind spot is located.



▴ The sensitivity of a dark-adapted eye peaks at 8-15° from the fovea

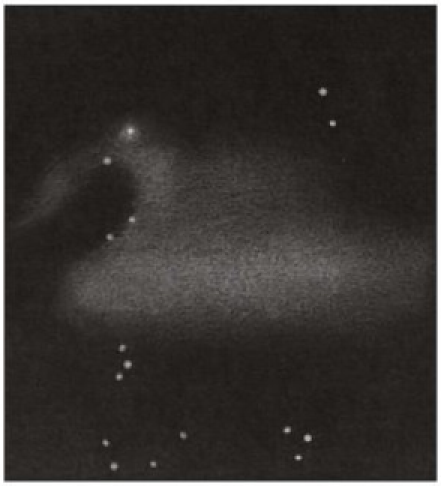
TOP TARGETS **TO TEST YOUR SKILLS**

Master the tips and techniques here and you'll have no difficulty exploring these objects

M106

RA 12h 20m, dec. +47° 14′

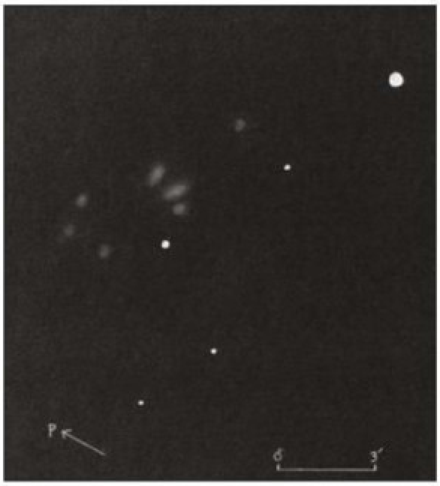
M106 is an 8th-magnitude spiral galaxy in the constellation of Canes Venatici and is highest in evening skies in spring. It's possible to see M106's delicate spiral structure within the general elliptical halo in good skies and larger instruments by increasing the magnification until this structure has an apparent size of about 1°. This is the size at which the eye and brain work together best to see dim, low-contrast detail.



THE SWAN NEBULA, M17

RA 18h 22m, dec. –16° 10m

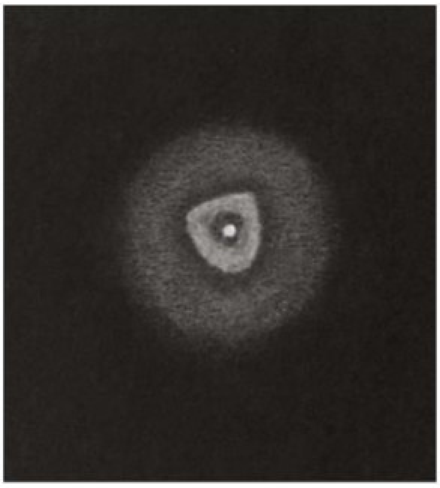
The Swan Nebula lies at the northern edge of Sagittarius and is best in August evenings, when it is low in the southern sky. Use an ultra-high contrast filter and low powers to frame the object nicely with some background sky, but use higher magnifications to pull out details like the finer points of the Swan's neck on the western side. Practise your averted vision to see the fainter separate nebulous region off the eastern side.



COPELAND'S SEPTET

RA 11h 39m, dec. +21° 56′

Copeland's Septet is a compact group of small galaxies in Leo, best seen in spring. The galaxies range from mag. +13.7 to +15.2. The brighter members are not too difficult to spot in 8-inch or larger scopes under dark skies but to see all seven members is harder. Good dark adaption and averted vision are essential; also switch to using higher powers to darken the background, improve the contrast and allow the fainter members to be detected.



THE ESKIMO NEBULA NGC 2392

RA 7h 30m, dec. +20° 53′

The 9th-magnitude Eskimo Nebula in Gemini is seen at its best in winter months. Its high surface brightness allows you to use high powers to best bring out details of the centre, especially the Eskimo's face, although you will need steady skies. In very good seeing conditions try bumping the power right up by using a Barlow lens with your eyepiece. If the view deteriorates, back off a bit.

THE ANDROMEDA GALAXY, M31

RA 0h 43m, dec. +41° 21′

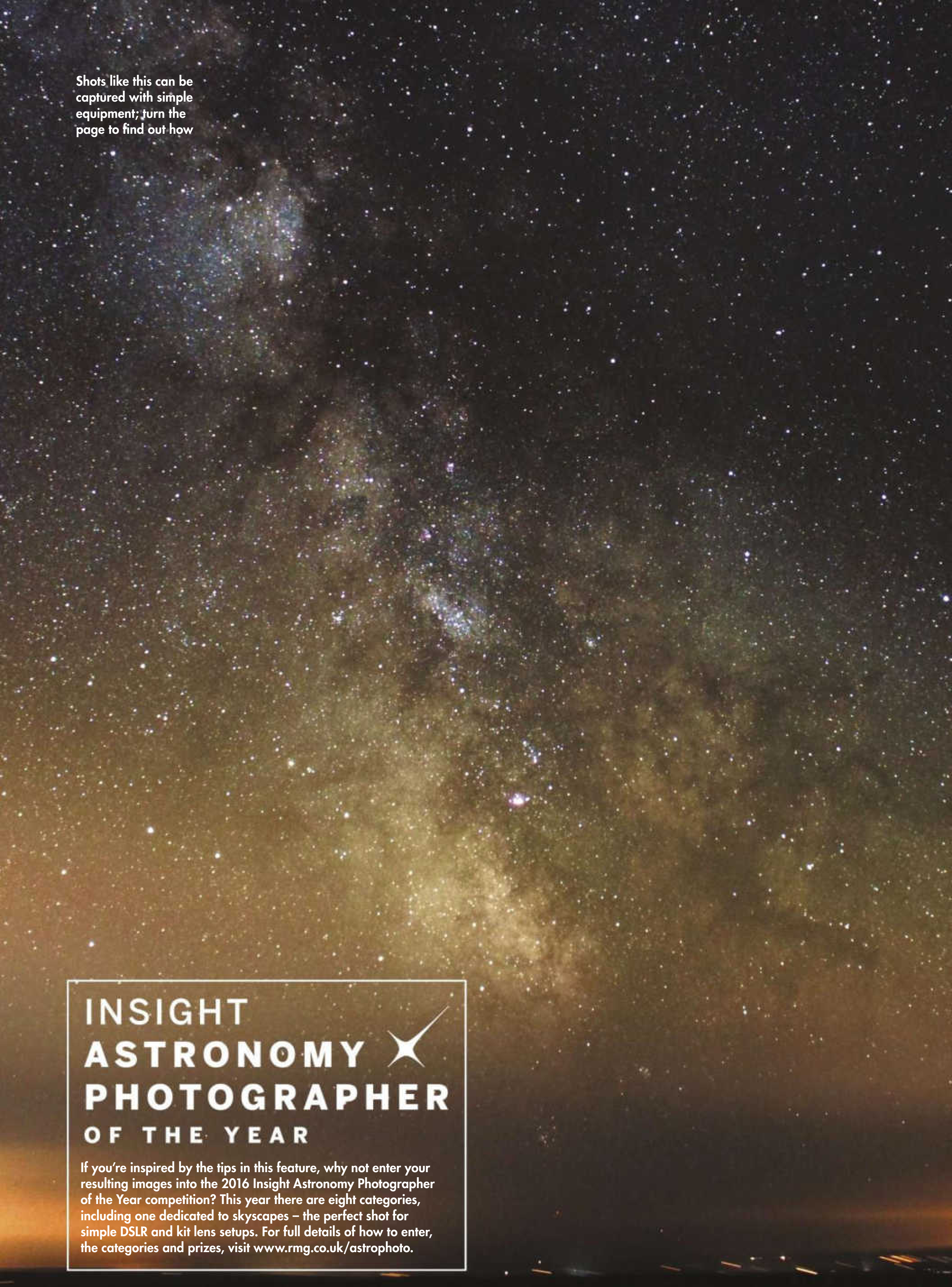
The huge Andromeda Galaxy, which is nearly overhead in late summer and autumn, is a great object for practising the use of lower magnifications combined with sweeping the eyepiece to create the movement within the field that will allow you to pick up the edges of the very low gradient eastern (lower) edge. Use higher magnifications to pull out details of the dust lanes on the northern edge.

THE WESTERN VEIL NEBULA, NGC 6960

RA 20h 46m, dec. +30° 46′

The Veil Nebula in Cygnus sits overhead in the summer. The brightest part, around 52 Cygni, is the Western Veil and is 1.5° in length. For the best overall view of the whole object use the minimum useful magnification together with averted vision and an OIII filter to improve the contrast. Experiment with higher powers to see if you can see some of the fine sinuous structure in the heart of this object.

MARTIN LEWIS X 8, GRAPHS BY PAUL WOTTON/REF: MARTIN LEWIS



Shots like this can be captured with simple equipment; turn the page to find out how

INSIGHT ASTRONOMY PHOTOGRAPHER OF THE YEAR

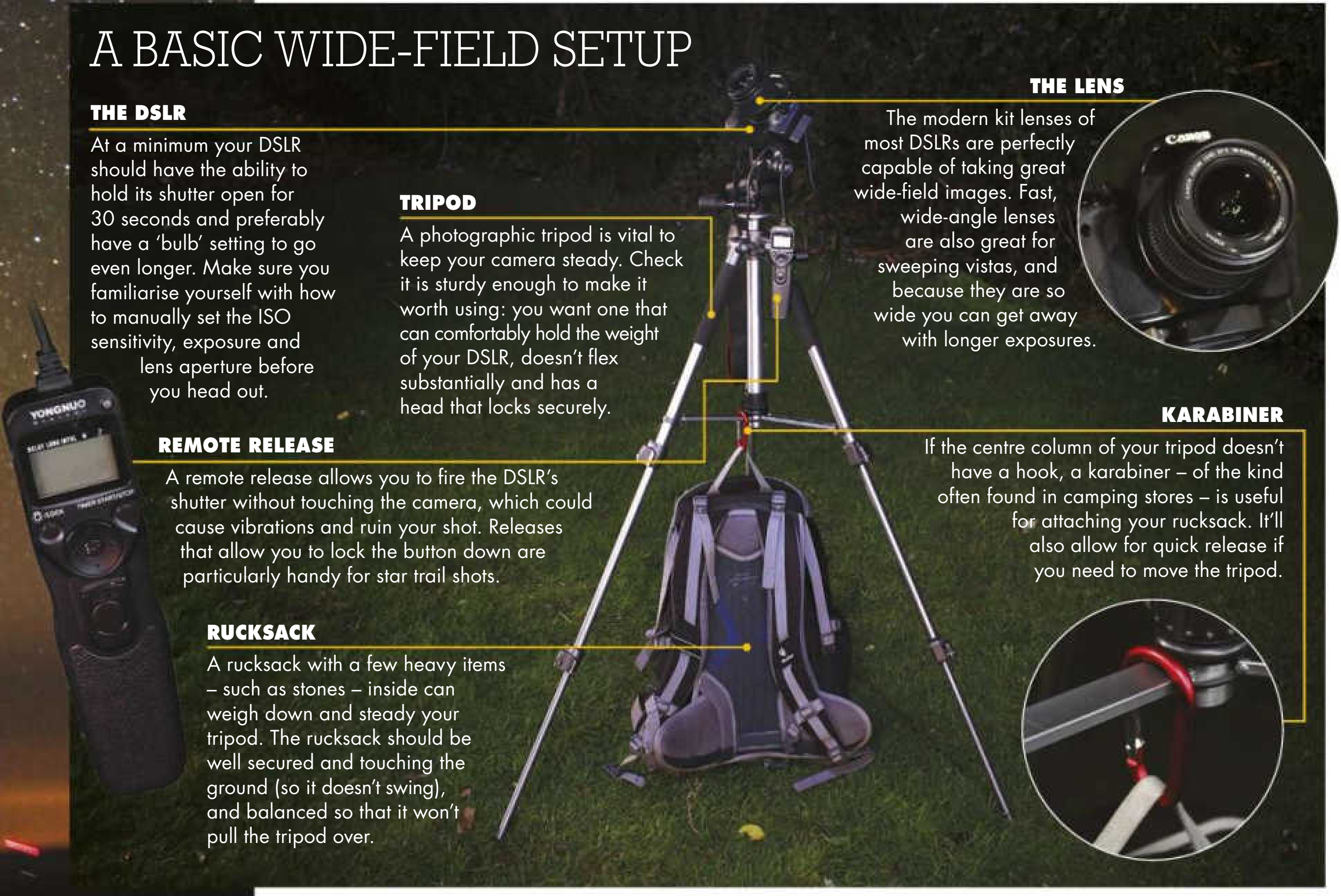
If you're inspired by the tips in this feature, why not enter your resulting images into the 2016 Insight Astronomy Photographer of the Year competition? This year there are eight categories, including one dedicated to skyscapes – the perfect shot for simple DSLR and kit lens setups. For full details of how to enter, the categories and prizes, visit www.rmg.co.uk/astrophoto.

Widen your horizons

Will Gater looks at the attraction of the humble DSLR and kit lens for wide-field astrophotography

Have you ever been on holiday looking up at a spectacular night sky and thought ‘wow, I’d love to get a picture of this’? Or maybe you’ve been on a walk or camping trip in a remote area and wanted to photograph the glowing Milky Way or a picturesque nightscape. Chances are that any weighty tracking mount, telescope or CCD you own was sitting safely at home; but what about a trusty DSLR and photographic tripod? This lightweight setup is remarkably versatile, and even if you’re an experienced imager in other areas you may be surprised at what you can achieve with it. In this feature we’ll look at how this equipment, coupled with a basic wide lens, can be used to capture the night sky. ▸

A BASIC WIDE-FIELD SETUP



THE DSLR

At a minimum your DSLR should have the ability to hold its shutter open for 30 seconds and preferably have a ‘bulb’ setting to go even longer. Make sure you familiarise yourself with how to manually set the ISO sensitivity, exposure and lens aperture before you head out.

TRIPOD

A photographic tripod is vital to keep your camera steady. Check it is sturdy enough to make it worth using: you want one that can comfortably hold the weight of your DSLR, doesn’t flex substantially and has a head that locks securely.

THE LENS

The modern kit lenses of most DSLRs are perfectly capable of taking great wide-field images. Fast, wide-angle lenses are also great for sweeping vistas, and because they are so wide you can get away with longer exposures.

REMOTE RELEASE

A remote release allows you to fire the DSLR’s shutter without touching the camera, which could cause vibrations and ruin your shot. Releases that allow you to lock the button down are particularly handy for star trail shots.

KARABINER

If the centre column of your tripod doesn’t have a hook, a karabiner – of the kind often found in camping stores – is useful for attaching your rucksack. It’ll also allow for quick release if you need to move the tripod.

RUCKSACK

A rucksack with a few heavy items – such as stones – inside can weigh down and steady your tripod. The rucksack should be well secured and touching the ground (so it doesn’t swing), and balanced so that it won’t pull the tripod over.

ALL PICTURES: WILL GATER

The flexibility of DSLRs, not to mention the fact that many people have them before they get into astronomy, means that they are a great starting point for budding astrophotographers. Combined with a cheap photographic tripod, a DSLR can produce attractive nightscape images of planetary conjunctions, constellations and moonrises as well as atmospheric phenomena. And – as we've outlined on the opposite page – there are several celestial sights that really lend themselves to being photographed with this simple setup. The main advantage that a DSLR offers over a compact digital camera is that its shutter can be left open for an extended period; in astrophotography this can be anywhere from a few seconds, for bright twilight nightscape scenes, to 30 seconds or more for a shot of star trails or the Milky Way. DSLRs also tend to produce cleaner, less 'noisy', images than compact cameras and – generally – they are much more sensitive. In this feature we're going to be focusing mainly on using a DSLR on a static photographic tripod. While fast, more expensive, wide-angle lenses work really well for this kind of astrophotography, we'll assume that you're using a standard kit lens, such as the 18-55mm that sometimes comes with Canon's beginner DSLRs.

Let's look first at how to take a basic nightscape shot. With your camera secured on its tripod, arrange and focus your shot in the viewfinder. Most modern DSLRs have a live view function that makes focusing on a star using the rear screen very easy. If yours doesn't, the camera's autofocus can sometimes be used to focus on a very distant streetlight before moving back to your subject.

Once the view is focused and you're happy with the composition, its time to set the exposure length and ISO sensitivity on the camera. For twilight scenes – for example some bright planets setting over a horizon – a few seconds should be fine. When setting the ISO, remember that the higher the value, the noisier the image will get. Opening up the lens aperture can allow in more light, but this is sometimes at the expense of ▸

WILL GATER X 6, ISTOCK

▲ ▸ Shooting nightscapes offers the chance to capture events such as conjunctions (above) and moonrises (right) in an Earthly context

CALCULATE YOUR SKY COVERAGE

If you're wondering which celestial targets will fit nicely in your camera's field of view, free planetarium program Stellarium (**www.stellarium.org**) has a built-in field of view plugin that can show you the area of sky your camera/lens combination covers.

BEYOND THE MILKY WAY

Wide-field astro imaging isn't just about shooting nightscapes or the Milky Way. Here are some other phenomena that can be photographed well with a DSLR and a tripod

AURORAE

If you're lucky enough to visit the Arctic Circle or see a bright auroral display from the UK, a DSLR and tripod are all you need to capture this stunning celestial sight. Keep your exposures short (no more than 10-20 seconds) to capture the details in fast-moving auroral curtains.

◀ METEORS

Meteors are hard to photograph. You need to be lucky that one passes through your camera's view, and even if it does it might not show up. On a meteor shower peak night, set the aperture of your lens fully open, use a high ISO (1600-3200) and take many exposures of around 10 seconds each.

▲ STAR TRAILS

A star trail image shows the apparent motion of the stars across the sky. Point your DSLR anywhere in the night sky (near Polaris makes for a good shot) and take at least 10-15 minutes' worth of 60-second exposures. The final image can be made with a layer-based editor or software like that found at www.startrails.de.

NOCTILUCENT CLOUDS ▶

Noctilucent – 'night shining' – clouds are an atmospheric phenomenon seen during the summer months here in the UK. Their bright, expansive, nature and intriguing structures make them ideal for DSLR photography. An exposure of a few seconds and a moderate ISO setting should pick up most displays easily.

GETTING THE SHOT

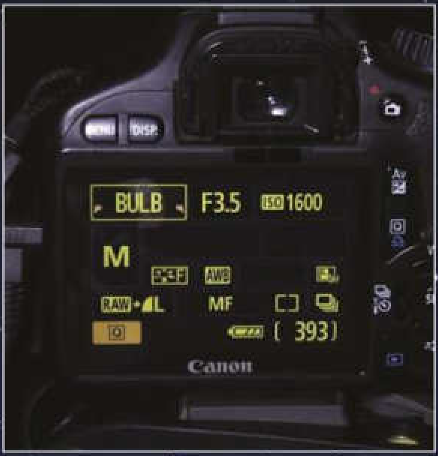
In this tutorial we'll look at how to create a wide-field image of the Milky Way with just a static tripod, wide lens and a DSLR. This process also works well on other large subjects like constellations and can even be used to capture extreme wide-field shots of comets

1 SECURE YOUR TRIPOD

First set up your static tripod. If you're out in the wilderness, check its legs aren't going to sink into mud, sand or snow. If you find the tripod wobbles in the wind, reducing the extension of the legs can sometimes help. A carefully attached rucksack (see page 15) can be used to add weight to the tripod for stability.

2 FOCUS THE LENS

One way to do this is to focus on a very distant streetlight using the camera's autofocus. If your DSLR possesses a live view screen, a simple and accurate alternative is to centre a bright star in the viewfinder, switch on the live view function and manually adjust the lens's focusing ring until you get the smallest and sharpest view of the star.



3 ADJUST YOUR SETTINGS

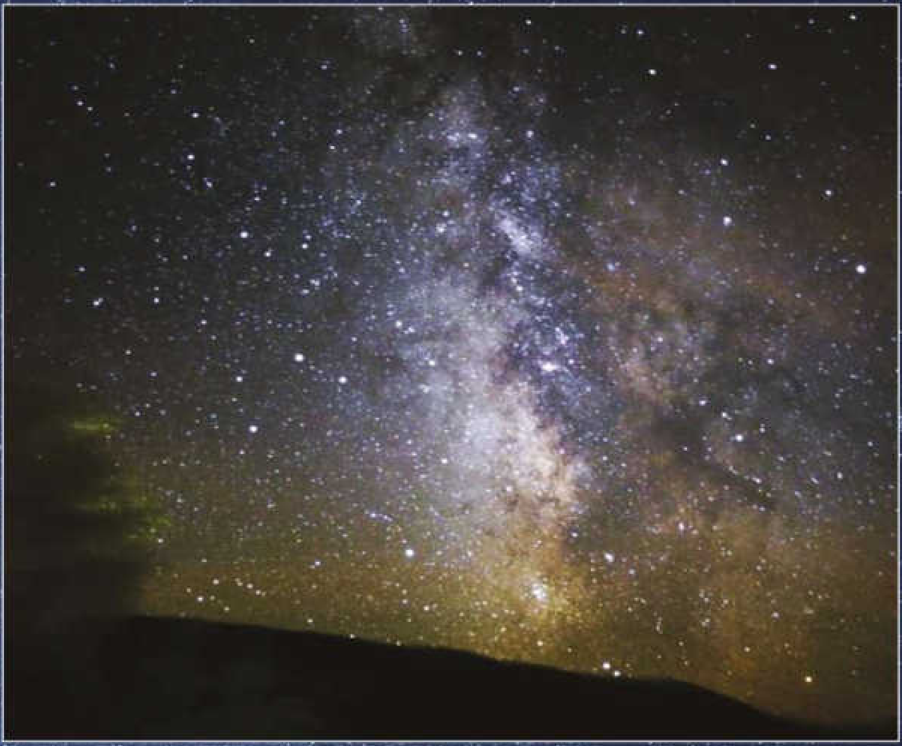
Set the exposure length, aperture and ISO. Take a few test shots to see what exposure length you can get away with before star trailing becomes evident. ISO and aperture settings will largely depend on your camera and what you're shooting – we've given some tips for certain targets on page 17. For the Milky Way we're going to use 30-second exposures at ISO 1600.

4 SNAP AWAY

Once you've centred your subject in the field of view – here we were shooting the central region of the Milky Way – switch your camera to continuous shooting mode and take a series of uninterrupted images. A total of five minutes' worth of individual exposures will be enough to begin with.

5 ALIGN AND STACK

After you've captured your images you'll need to use stacking software to combine them; we used DeepSkyStacker (http://deepskystacker.free.fr/english/index.html). Be sure to select the hot-pixel removal option. DeepSkyStacker can also be used to calibrate your image with any dark frames you may have captured.



6 TEASE OUT THE DETAIL

Once you have an image from DeepSkyStacker that you're happy with it's best to save it as a TIFF or PNG file, then bring it into a layer-based editing program such as Photoshop or GIMP for any final tweaks. Use the Levels adjustment tool (available in most photo editing software) to brighten the image, and adjust the colour balance if necessary.

▲ **A simple DSLR and tripod combo can also deliver shots of asterisms and constellations; here, the W of Cassiopeia shines brightly**

▸ more distorted stars towards the edges of the field of view. The trick with nightscape photography with a DSLR and tripod, then, is to balance the detail you pick up in your image with the noisiness of the picture, the sharpness of the stars and how much the stars have trailed – we'll come to that last factor in a moment. Really, the best way to find what works for your setup is to play around with different settings until you're happy with the shot.

Pinpoints no more

If your exposures are too long you'll notice that the stars, rather than being points of light, will have 'trailed' into short lines. This is because of Earth's rotation. Over the course of a night the stars all appear to slowly track across the sky and even an exposure of 30-40 seconds is enough to pick up this gradual movement. When shooting with a static tripod and DSLR, which isn't tracking the night sky on a driven mount, you have to take this into account when setting our exposure length. Otherwise, your shots will be blurred in this way.

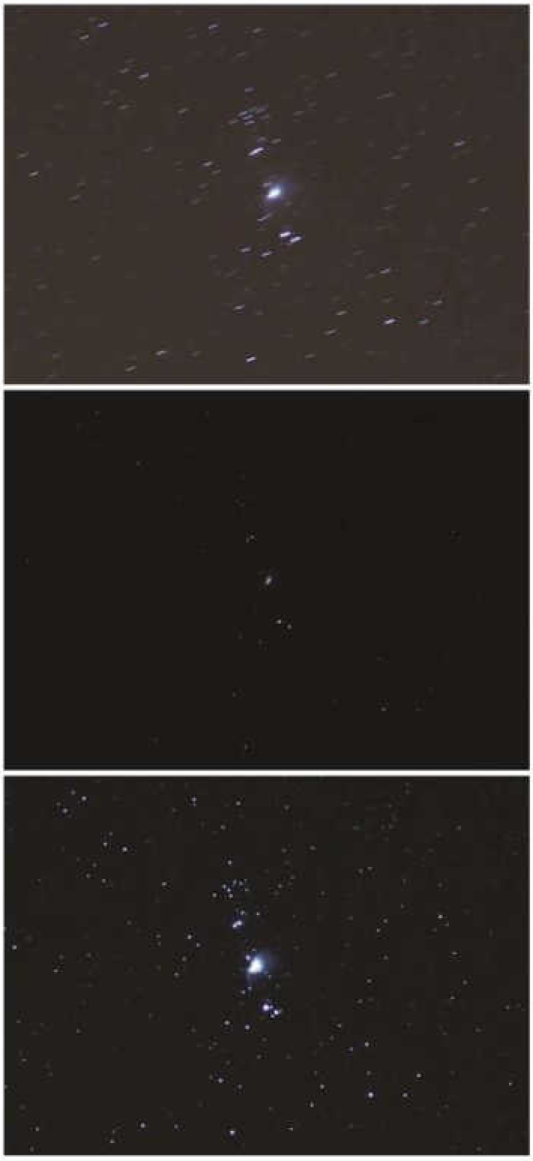
As well as watching exposure length, there are two other approaches to avoiding star trailing in your static tripod and DSLR shots. The first is to use the shortest focal length on your lens. With a shorter focal length the time it takes for trailing to become noticeable is longer and so you can get away with longer exposures. Trailing is also more evident the farther away from the celestial poles you point your camera, so one way of limiting trailing is to image the sky near to the pole star, Polaris (mag. +2.0 Alpha (α) Ursae Minoris) in Ursa Minor.

What if you want to take more deep and detailed shots of constellations and the Milky Way with just a photographic tripod and DSLR? One way is to stack several short exposures – where the length of the exposure means star trailing isn't evident – together. On the page to the left we explain exactly how to do this in detail. Ideally, you'd have the DSLR and lens mounted on a tracking mount (for example, an AstroTrac, Vixen Polarie or Sky-Watcher Star Adventurer) that follows the sky as it moves. Then you could take much longer exposures without worrying about star trailing. Even so, if you don't have one of these, or are off to some remote destination, we hope we've convinced you not to leave your DSLR and tripod at home on the next clear night.

DARK FRAMES

Once you've taken enough exposures to stack together, capture several 'dark frames' – these are shots taken with the same settings and conditions, but with the lens cap on. These can then be used in stacking software to reduce the noise in your final image.

▼ **Here we see how stacking several short images can help to reduce star trailing. In the top image, a crop of a 25-second shot taken at ISO 400 with a 50mm lens, the trailing is clear. The middle image is an exposure of just two seconds; stars are not trailed, but there is less detail. In the bottom image several short (and crucially, untrailed) exposures have been stacked for a good result.**



ABOUT THE WRITER

Will Gater is an astronomer, science writer and author of several popular astronomy books. He also appears on TV and radio to talk about space. Find him on Twitter: @willgater

WILL GATER X 8, ISTOCK

LISTENING IN

OBSERVING PERSEID METEORS BY RADIO

Tune in to the right frequency and you'll be able to hear the Perseids as they fly through the sky, writes **Vincent S Foster**

ABOUT THE WRITER

Vincent S Foster has been an amateur astronomer for over 50 years. He chairs the Hydrogen-Alpha Solar and Bright Nebula observing programmes for the Astronomical League.

▲ **Catching the Perseids by radio in 2016 is a good way of monitoring activity while the waxing gibbous moon is still up before 1am**

The Perseid meteor shower could be interfered with in 2016 by light from a waning gibbous Moon. But all is not lost: it's easy to track the meteors by listening to them on your FM radio at home or in your car.

Meteors burn up in the atmosphere and leave an ionised trail, which acts like a mirror to reflect transmitted signals from FM radio stations hundreds of kilometres away. You can find one of these stations by looking for big cities far enough from you and then searching online for a suitable radio station transmitting from there.

> **"Radio can detect smaller particles than can be picked up by visual observations"**

All meteors can be detected like this, and it's because radio can detect smaller particles than can be picked up by visual observations. The human eye can only see shooting stars brighter than sixth magnitude, but radio can detect meteors that are at least five times dimmer. This simple way of observing can also be employed during daylight hours.

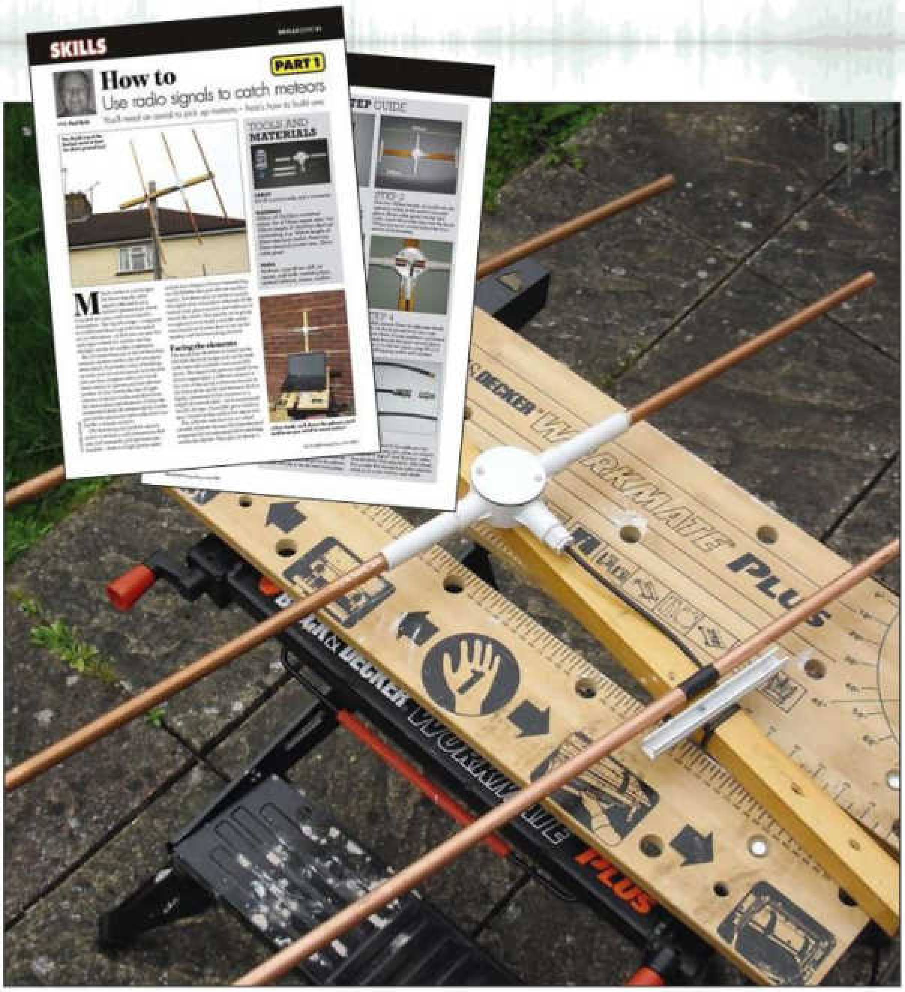
Sight versus sound

The one serious drawback to observing meteors by radio is that you can't tell what direction they came from. Visual observers can easily tell if it was a Perseid meteor emanating from a radiant in Perseus or if it was a sporadic meteor that came from somewhere else. Radio listeners can't, but radio observation is something you can do when visual conditions aren't good. So the best approach is to use your radio on cloudy nights and use your eyes when the sky's clear.

You can also make radio observations of summer's standout meteor shower using an amateur radio set at a known TV or radar frequency. This method requires an amateur radio with a dipole antenna. It allows you to hear or record pings of varying intensities and lengths amid background static. If a setup like this is beyond your scope, you can hear a live broadcast of them on the internet. Just connect to Spaceweather Radio at www.spaceweatherradio.com.

While the number of signals you hear will depend on what equipment you have, the advantage of listening to meteors is that you can hear ones that are too faint to see. With the naked eye you can see the arrival of a particle as small as 1/100th of a gramme on a dark night, but dust grains much smaller than this can be detected using radio observation. ▸

THINKSTOCK X 3, PETE LAWRENCE


SKILLS
How to
PART 1
Use radio signals to catch meteors
TOOLS AND MATERIALS
STEP GUIDE
BLACK & DECKER WORKMATE PLUS

▲ We showed you how to construct a dipole antenna in the *How to* section of our June 2015 issue

THINKSTOCK X 3, PAUL HYDE, WIKIPEDIA

▲ Spaceweather Radio will broadcast the sounds made by the Perseid meteors

► In order to do so, however, you have to approach meteor showers differently, as you'll need to know the date of peak activity – you can do so online on the International Meteor Organization's website at at www.imo.net. There are also daytime meteor showers that can only be observed by radio because the radiant is close to the Sun. Among them is the Arietid shower, which lasts from late May until early July each year and peaks around 7 June. Arietid meteors stream out of the constellation Aries. Their source is unknown, but some astronomers suspect they come from the sungrazing asteroid Icarus, the meteoroids hitting Earth's atmosphere with a velocity of 39km/s.

Another annual daytime meteor shower around the same time is the Zeta Perseids, which occurs between 20 May and 5 July. Maximum rates are on 9 June. This meteor shower is one of the strongest of the year, with a maximum rate of 50-80 per hour. The Beta Taurids is a third daylight shower, which is active between 5 June and 17 July. It exhibits a relatively flat maximum each year around 28 June. Beta Taurid meteors come from the same meteoroid stream as the Taurids.

Despite not producing peak rates as high as those of the Geminids, the Perseid meteor shower remains the favourite for many. Besides being rich in bright meteors, it also occurs during summer in the northern hemisphere, whereas other similarly productive meteor showers, such as the Geminids, take place in the cold nights of December.

◄ Any device can listen in on meteors as long as it can pick up an FM signal

When to watch

The highest observed rates on any given night are likely to be seen when the radiant is highest in the sky late at night. In some years, when the Earth encounters dust trails from old returns of the Perseids' parent comet 109P/Swift-Tuttle, there can be more than one Perseid peak. In 2016 the Moon will be brightening, though it sets an hour after sunset.

Visual observing conditions will be good for the early Perseids between 26 July (when there will be a last quarter Moon) and 2 August (when there will be a new Moon). However, conditions will then become more unfavourable, with a full Moon occurring on 18 August, which is after the Perseids maximum.

The Perseids peak on the night of 12/13 August for UK observers, when there will be a 70 per cent illuminated waxing gibbous Moon. On the night of maximum, the Moon will have already risen before twilight begins but sets again at around 1am.

Radio observations are better overnight when human activity is low. Also, the number of detectable meteors increases after midnight when Earth's leading edge travels into the stream of sporadic or shower meteors. These meteors tend to enter the atmosphere at a greater speed because of Earth's velocity through space of 29.8km/s. This higher energy translates into higher levels of ionisation. As a result, many radio meteor observers conduct their observations between midnight and 7am.

STEP-BY-STEP GUIDE

How to find an FM station that will allow you to listen to meteors on your radio

STEP 1 You could listen to the sounds made by Perseid meteors by visiting www.spaceweatherradio.com, but it's much more fun (and rewarding) to catch the reflected radio waves yourself. First, make a note of the frequency of each station your FM radio is able to pick up as you adjust its tuner from the lowest setting to the highest one.

STEP 2 You need to find an FM radio station that doesn't broadcast on any frequencies on which you can already pick up radio stations – in other words, you need to identify a radio station that you can't hear from your location. We'll explain how to do this in the next three steps.

STEP 3 In order to get optimum results you need to find an FM radio station that is approximately 1,300km away from your location. This usually gives the longest-duration signal, thus increasing your chances of picking up the crackles of the radio waves reflected off the trails of meteors passing through Earth's atmosphere.

STEP 4 To find a suitable radio station use a compass centred on your location to draw three circles on a map, one at 200km, another at 1,300km and a third at 2,100km. Find an FM radio station that transmits on a frequency different from the ones you can hear on your FM radio from somewhere between the smallest and largest circles.

STEP 5 Though not 1,300km away, you could use a suitable radio station located within the UK – a list can be found on Wikipedia. You want the one with the highest broadcast power, which is measured in kilowatts – this will reveal meteors with the longest duration. You can check the power of all UK and Ireland FM transmitters at www.frequencyfinder.org.uk/FM_Stations.pdf.

...AVEC UNE...
...JE SUIS...

STEP 6 You'll hear meteors as brief bursts of speech or music. As the meteors arrive, you might also hear pops and whistles. It is best to observe after midnight – and not only because human activity is at its lowest. After this time, Earth's rotation puts us on the leading edge of our planet's orbital path through space, meaning that more 'slow' meteoroids enter our atmosphere, while faster ones leave brighter trails.

ASTROLOGY

AN ASTRONOMER'S VIEW

Astrology and astronomy were once the same discipline but, as **Alister Graham** explains, science has since moved on

The Babylonians believed that Mars's appearance in the night sky heralded the onset of war

Ask any astronomer if they believe in the ancient practice of astrology and the answer will likely be a resounding no. And yet the science of astronomy had its origins in this astrological belief system, which goes back a long way.

Perhaps not surprisingly, early civilisations regarded the stars and planets as evidence of supernatural powers that could magically affect their lives. From the writings of Babylonian priests, we know that they would 'interpret' various astronomical events as omens. Using their 'principles of analogy' or 'laws of correspondence', the Babylonian priests would claim to foretell the future state of affairs of their kings based on the positions of celestial bodies. For example, a red-coloured Mars was a sign of blood and imminent war; a stellar constellation resembling two fish referred to water.

By the time of the Egyptian empire, the messages in the heavens weren't just for the rich and powerful – the stars and planets now held advice for everyone. Egyptian astrologers would provide horoscopes founded on the belief that the instant of everyone's birth established character and disposition. With such an increased customer base and the new personal connection to the heavens and the gods, it's easy to see why astrology flourished.

The ancient Egyptians also believed that their Sun god Ra was swallowed every night by the sky goddess Nut, then reborn the following day. Night fell when Nut returned to, and embraced, the Earth god Geb, her star-studded body creating a canopy over the Earth. Storms during the day were thought to occur when Nut came close to Geb, and Geb's laughter was thought to be the origin of earthquakes.

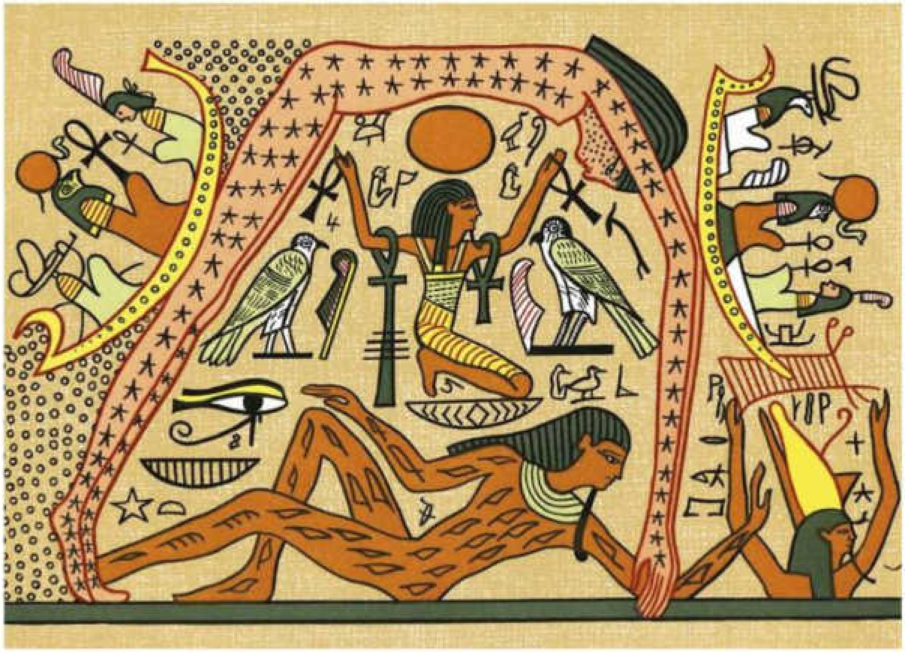
The ancient Greeks further developed the system of correspondences that linked people with the heavens. It was Aristotle's endeavour to mathematically describe this magical world view that led to what we know today as astrology.

Greeks and Romans

The Greeks meshed the Egyptian system of attaching significance to the angular distance separating the Moon and planets from the Sun with the Babylonian zodiac. The zodiac shows which constellation the Sun, and thus the powerful Sun god, appears to reside in. It also dictates one's 'star sign'.

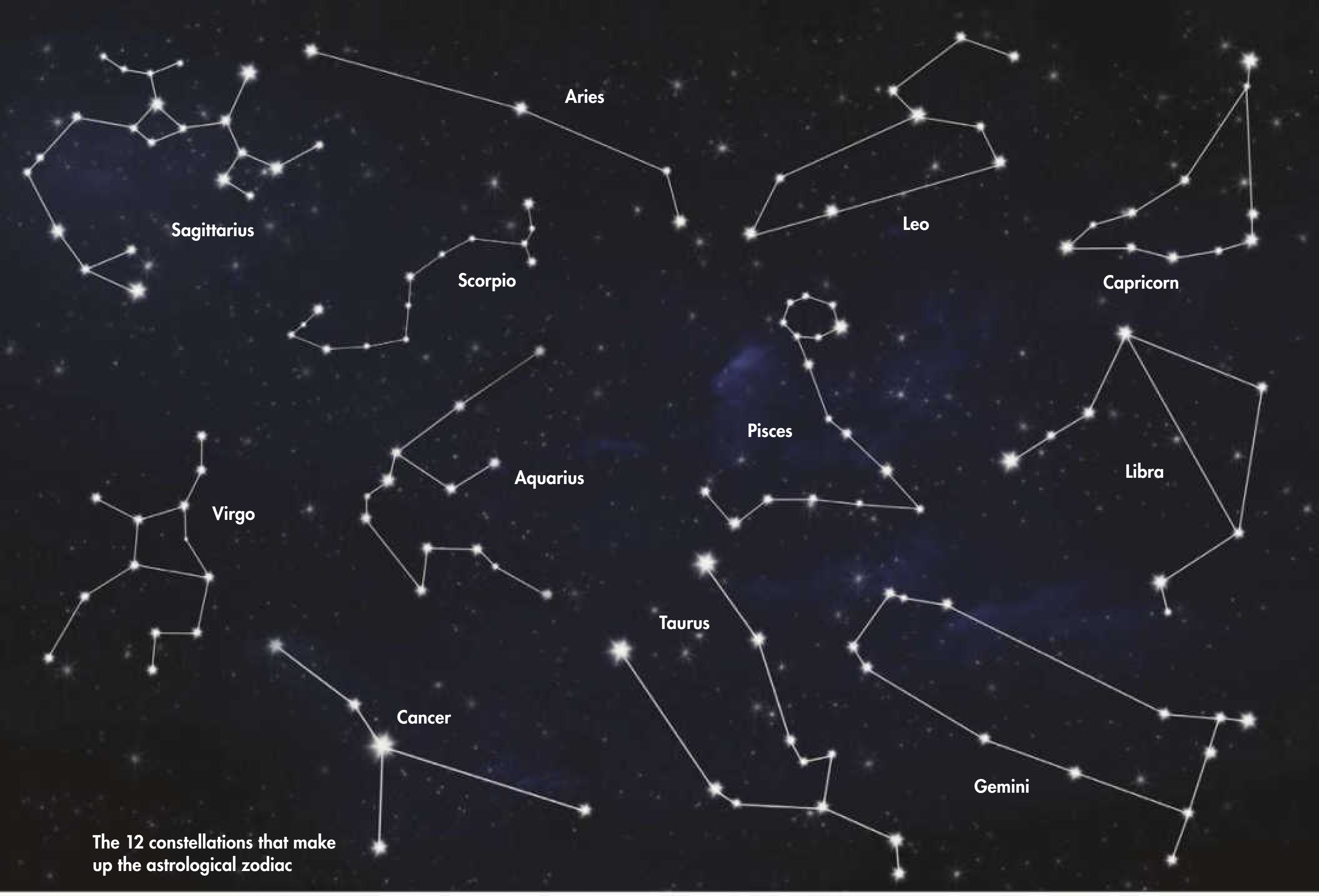
The Greeks believed that the relative proximity of the Sun god to the other 'gods' (planets) at the time of one's birth influenced one's personality. Similarly, the association of the Sun god with a particular constellation determined our character. Further modifications came from the Romans, notably Ptolemy in the second century AD, perhaps best known for mistakenly believing Earth was the centre of the Solar System.

As astrology developed, each star sign came to have a fictional creature or figure ►



▲ **In ancient Egyptian lore, Geb the Earth god was blanketed at night by Nut the sky goddess**

THINKSTOCK, © IVY CLOSE IMAGES/ALAMY X 2,



The 12 constellations that make up the astrological zodiac

▸ associated with it, whose form was traced out by the brightest stars of a constellation. Those born under the water sign Pisces are supposed to possess a love of the sea and have numerous skills connected with water and rivers, the flowing nature of which is claimed to make Pisceans adaptable to changing situations. They are also said to have a certain degree of dualism due to the presence of two fish in this constellation and are thus compassionate to others' points of view.

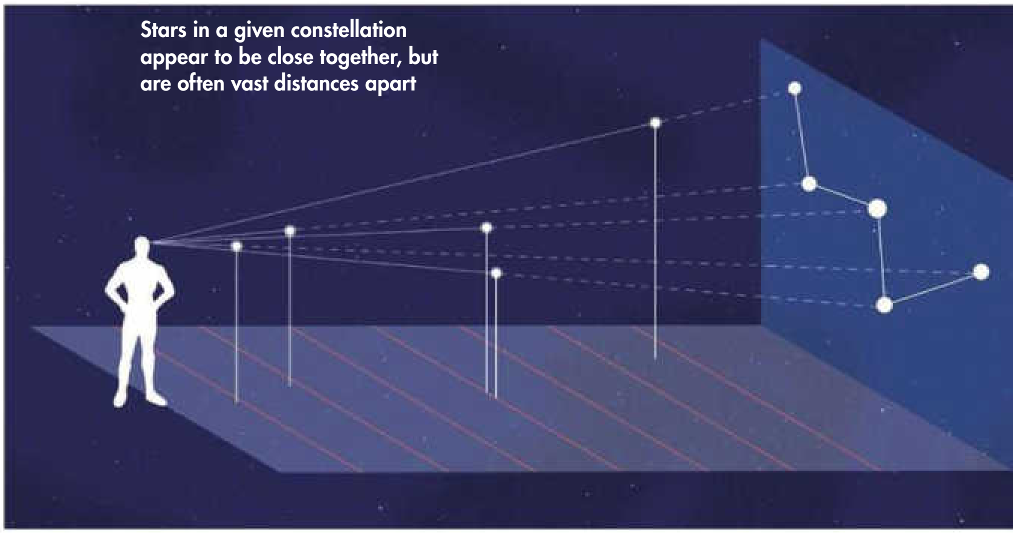
To give other examples of how these so-called laws of correspondence work, those born under the sign of Leo are said to be proud, forceful leaders; those born under Aries are allegedly headstrong and impulsive; Geminis have split personalities, are social and good communicators; Taureans have a plodding, patient, stubborn nature; while Scorpios are self protective.

Astronomy and astrology used to be intertwined: Galileo (1564-1642) and Kepler (1571-1630) were expert astrologers. But as the forces of nature and the distances to the stars and planets were better understood, astrology shifted into the realms of pseudo-science. Today we know that there is no significant interaction between the Sun and the stars that define the constellations – the distances involved are simply too vast. Moreover, the stars of the constellations often have no physical association with each other, only appearing to do so when viewed from Earth. So the constellation Pisces, once connected with the Babylonian goddesses Anunitum and Simmah, the Syrian goddess Ashtarte, and the Greek goddess Aphrodite and her son Eros, is simply a scattering of self-gravitating nuclear fusion reactors – stars – spread across the Milky Way.

Gravitational force

But are there any known forces exerted by stars and planets that might affect us? Gravity and electromagnetism are the only candidates, yet are so weak as to be negligible. At birth, the obstetrician exerts a greater gravitational force on us than the planets and constellations, and a fridge magnet has a stronger electromagnetic influence. Moreover, solar flares result in the Sun's magnetic influence on Earth changing randomly from day to day, and at a level greater than that coming from the planets and stars. Even the lights of a hospital operating theatre, or local TV and radio stations, produce more radiation than that which arrives from space.

It therefore comes as little surprise, especially given that personality



Stars in a given constellation appear to be close together, but are often vast distances apart

SEBASTIEN BEAUCOURT/LOOK AT SCIENCES/SCIENCE PHOTO LIBRARY, THINKSTOCK, SOHO/NASA/ESA, REX/SIPA PRESS

▲ If astrology is to be believed, then more married couples should have purportedly 'compatible' star signs – but this is not the case

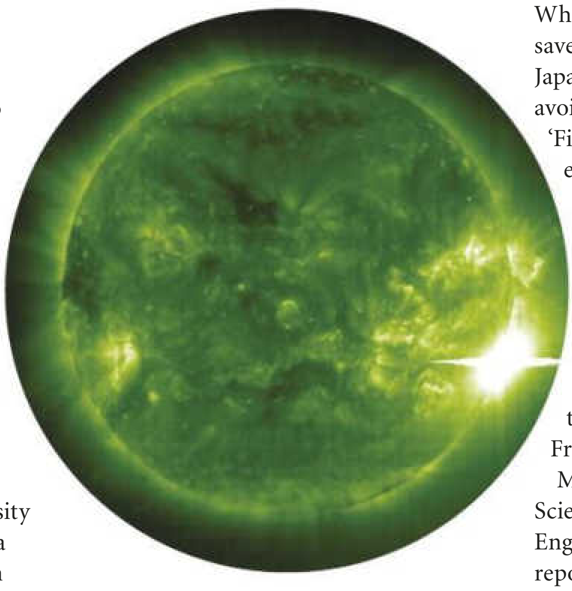
▲ Joan Quigley, who passed away in October 2014, acted as astrologer for US President Ronald Reagan following an assassination attempt

traits are supposedly based on those of mythological creatures in the heavens, that modern statistical studies using large numbers of people have shown no evidence that constellations or planets provide any insight into individual personalities. Marriage and divorce rates show no correlation with allegedly compatible and incompatible 'signs'. Scientists of every sign exist in equal numbers, as do entertainers and military personnel; there is no tendency for any of them to be of a particular star sign.

In 2003, Australian scientist and former astrologer Geoffrey Dean, and Ivan Kelly, a psychologist at the University of Saskatchewan in Canada, presented a study of over 2,000 'time twins' born in London. People born at the same time should, according to astrology, have very similar personalities. However, the study found no evidence of any more similarities between 'time twins' than between any randomly selected pair of people.

In another study, Dean asked 22 people to rate the accuracy of their astrological readings, but switched the phrases in half of them with their exact opposite meaning. Those who received the reversed readings rated them just as highly as those with unmodified horoscopes. In 2007 David Voas examined the birth dates of 10 million married couples in England and Wales. If people of a certain zodiac sign are indeed particularly compatible, then one would have expected to see this reflected in the star sign of their partner – yet the results revealed no such pairing.

So is there a plausible explanation for belief in horoscopes? One might be that, in general, they are often vague. This might explain how they succeed in making some people believers: when readings give specific predictions, subjects tend to forget those that didn't come true, but concentrate on those which seem accurate.



▲ Variations in solar flare activity have a greater influence on Earth than planetary motions

"At the time of our birth, the obstetrician exerts a greater gravitational force on us than the planets and constellations"

Popular appeal

Vast numbers of individuals and businesses base important professional and personal decisions on advice received from astrologers and daily horoscopes, which claim to help us find solutions. Who to date? Who to employ? Spend or save? In 1966 the number of births in Japan fell by over 25 per cent as couples avoided giving birth in the year of the 'Fire Horse', which comes around every 60 years and is said to result in daughters with such monstrous egos and lack of family loyalty that they bring bad luck to the father and future husband. It was heavily publicised in 1988 that former US President Ronald Reagan would plan his schedule around the writings of Joan Quigley, a San Francisco astrologer.

More recently, the US National Science Foundation (NSF) Science and Engineering Indicators study from 2014 reported that a whopping 45 per cent of Americans think that astrology is either 'somewhat' or 'very' scientific. It's a similar story in India, where many people, including top politicians, are reported to still consult with astrologers, in particular for the optimal timing of key private and public events. In contrast, the NSF report noted that only eight per cent of Chinese people believe in horoscopes.

Astrology's enduring appeal, despite its lack of any scientific foundation, says more about human psychology than it does about the power of the stars.

ABOUT THE WRITER

Prof Alister Graham researches the structure and dynamics of galaxies, and teaches through Swinburne Astronomy Online.

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BBC Sky at Night MAGAZINE

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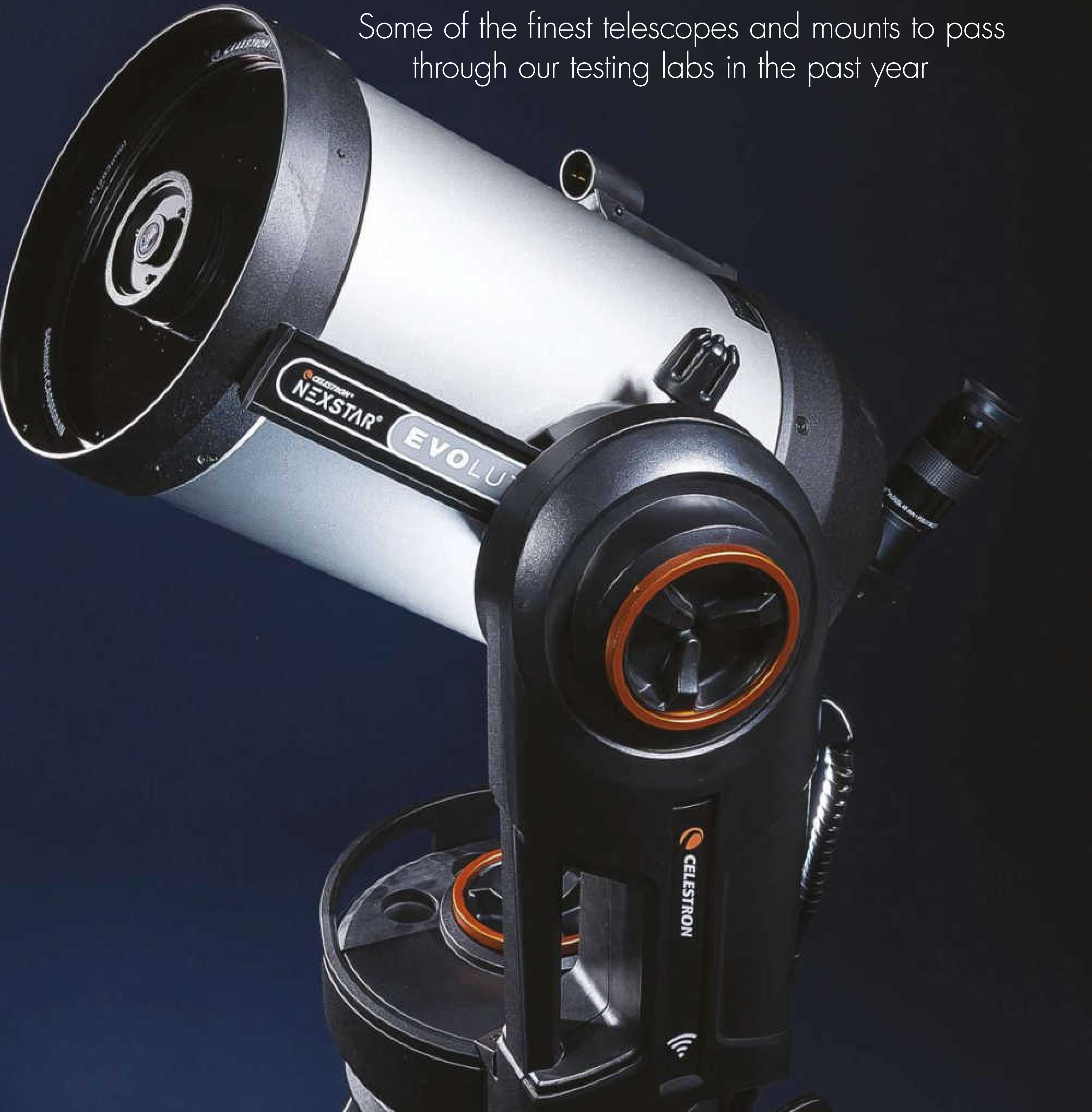
Some of the finest telescopes and mounts to pass through our testing labs in the past year



Celestron NexStar Evolution 8

A revolutionary 8-inch Schmidt-Cassegrain packed with innovative features

Telescope innovation and improvement continues apace, nowhere more evidently than with the Celestron NexStar Evolution 8, an 8-inch Schmidt-Cassegrain telescope on a computerised single fork arm. This altaz mount sits on a stainless steel tripod and comes with a star diagonal, Celestron's StarPointer red-dot finderscope, 40mm and 13mm eyepieces, and a mains power cable. The single fork arm mount has a useful carry handle, but it is within the arm that the innovation begins.

For starters there is an integrated lithium-ion phosphate battery. With this charged up you don't need an external powerpack – a long overdue touch.

The other innovative aspect in the mount is a built-in Wi-Fi network. Using this, you can connect wirelessly with a smartphone or tablet to control the scope, although a hand controller is supplied too

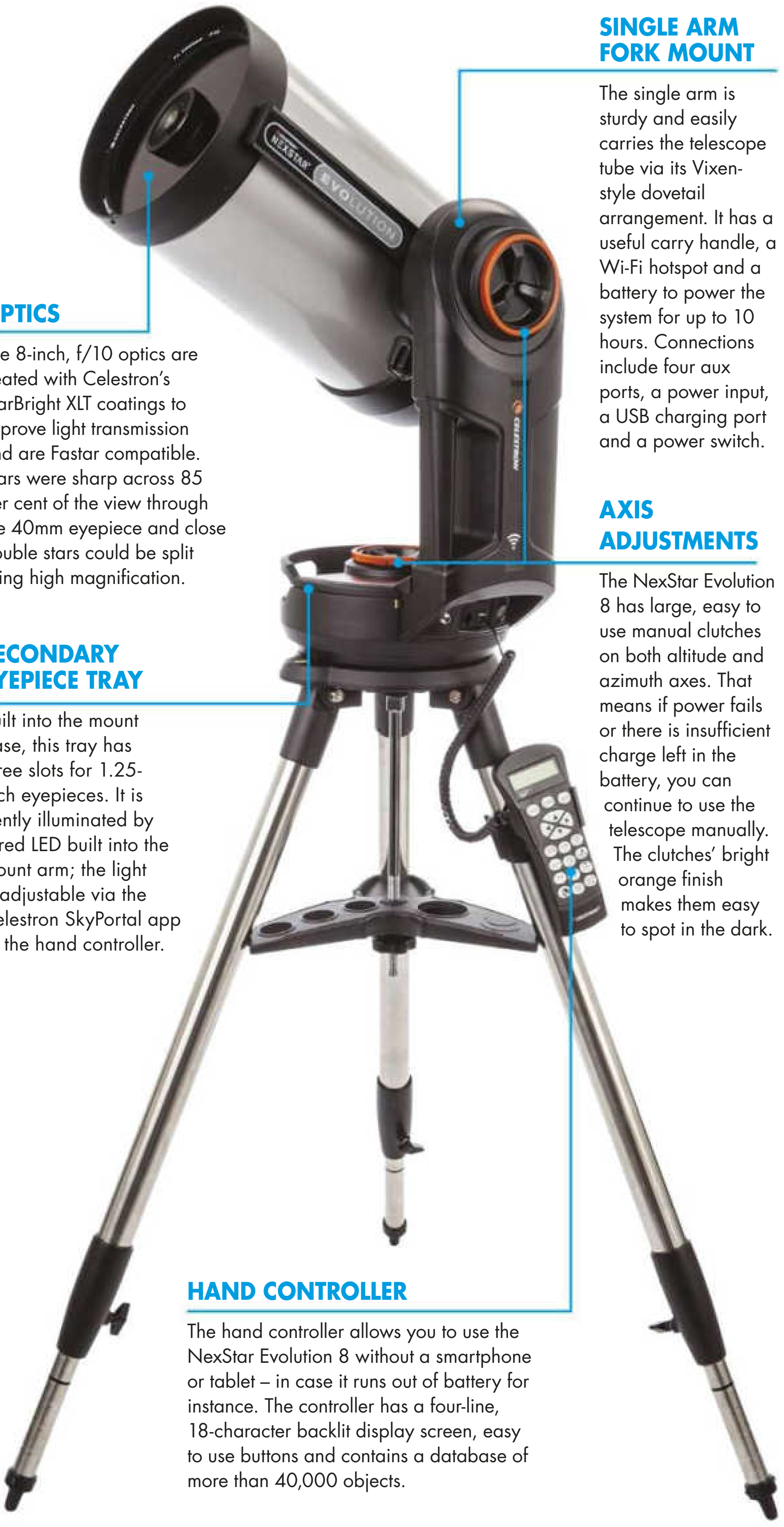
The secondary mirror can be replaced with a Fastar/HyperStar unit on which a CCD camera can be mounted. This speeds up the scope's focal ratio to f/2 – especially useful for imaging. Being an altaz setup, though, astrophotography is generally limited to the Moon and brighter planets; only short exposures of deep-sky objects at high ISOs are practical. Celestron has said a wedge will soon be available for long-exposure imaging.

Though the mount can be a little noisy when slewing, once tracking it is very quiet. This is a great telescope that makes astronomy even more accessible – especially to those in tune with the latest technology.

VITAL STATISTICS

- **Price** £1,799
- **Optics** Schmidt-Cassegrain
- **Aperture** 203.2mm (8 inches)
- **Focal length**: 2,032mm (f/10)
- **Mount** Computerised single fork arm altaz
- **Extras** NexStar+ hand controller, 40mm eyepiece, 13mm eyepiece, star diagonal, Celestron StarPointer red-dot finder
- **Weight** 18.4kg
- **Supplier** David Hinds, www.celestron.uk.com, 01525 852696

VERDICT ★★★★★



OPTICS

The 8-inch, f/10 optics are treated with Celestron's StarBright XLT coatings to improve light transmission and are Fastar compatible. Stars were sharp across 85 per cent of the view through the 40mm eyepiece and close double stars could be split using high magnification.

SECONDARY EYEPIECE TRAY

Built into the mount base, this tray has three slots for 1.25-inch eyepieces. It is gently illuminated by a red LED built into the mount arm; the light is adjustable via the Celestron SkyPortal app or the hand controller.

SINGLE ARM FORK MOUNT

The single arm is sturdy and easily carries the telescope tube via its Vixen-style dovetail arrangement. It has a useful carry handle, a Wi-Fi hotspot and a battery to power the system for up to 10 hours. Connections include four aux ports, a power input, a USB charging port and a power switch.

AXIS ADJUSTMENTS

The NexStar Evolution 8 has large, easy to use manual clutches on both altitude and azimuth axes. That means if power fails or there is insufficient charge left in the battery, you can continue to use the telescope manually. The clutches' bright orange finish makes them easy to spot in the dark.

HAND CONTROLLER

The hand controller allows you to use the NexStar Evolution 8 without a smartphone or tablet – in case it runs out of battery for instance. The controller has a four-line, 18-character backlit display screen, easy to use buttons and contains a database of more than 40,000 objects.

ALL PHOTOS: WWW.THESECRETSTUDIO.NET

iOptron CEM 60 equatorial mount

A surprising Z-shaped mount that offers novel solutions to common problems

Astronomers want all sorts of things from a telescope mount, but nothing is more challenging than the quest for good stability allied with lightness. The CEM 60 tackles these conflicting needs head on with its unusual design.

The offset Z shape results in the RA axis being substantially supported in main bearings at two locations. Placing the mount load between two bearings in this manner should produce a better mechanical solution than the usual mounting method that has the bearing to one side of the payload.

The supplied Go2Nova 8407 hand controller has an internal 32-channel GPS receiver that supplies date, time and location information automatically. It took less than 45 seconds to initialise.

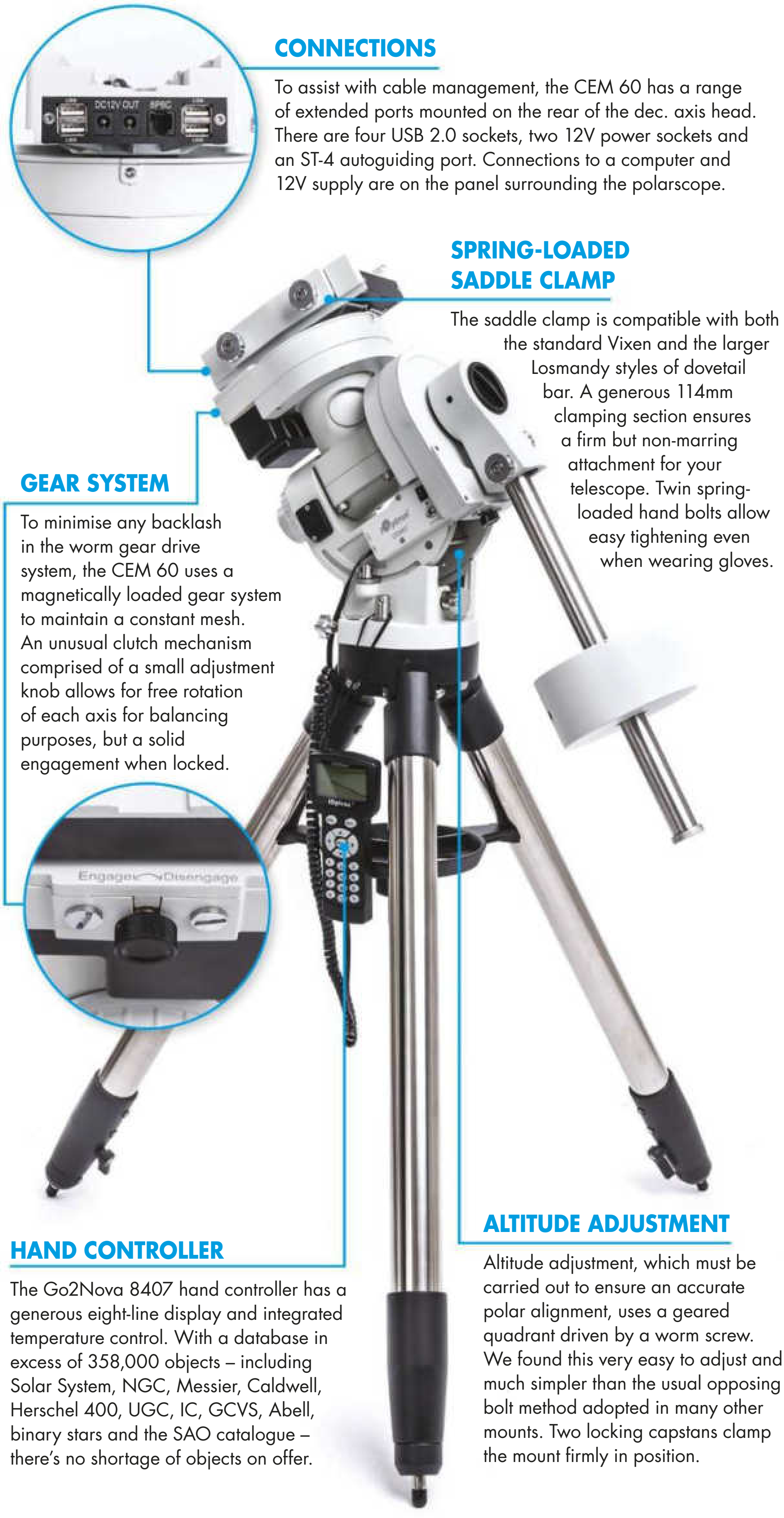
We were also very impressed with how easy the scope was to align (with two methods of polar alignment) and how quiet the mount was when slewing at full speed: your neighbours won't hear this one. And when it came to imaging, we captured five- and 10-minute guided exposures using our 98mm refractor with an off-axis guider and were delighted with the very round stars that we recorded. The mount was certainly easy to guide using the standard ST-4 port for control.

The CEM 60 mount should be on any intermediate telescope user's shortlist, and we would particularly recommend it for astrophotography, a situation where payload capacity and stability are so important.

VITAL STATISTICS

- **Price** £2,299
- **Payload capacity** 27.2kg
- **Hand controller** Go2Nova 8407 with 32-channel GPS
- **Database** 358,000 objects
- **Flash upgradeable** Yes
- **Autoguider port** Standard ST-4
- **Extras** Flight case, polarscope, 12V cigar lighter cable, AC power supply, serial cable, 9.5kg counterweight
- **Weight** 12.3kg (without counterweight)
- **Supplier** Altair Astro, www.altairastro.com, 01263 731505

VERDICT ★★★★☆



CONNECTIONS

To assist with cable management, the CEM 60 has a range of extended ports mounted on the rear of the dec. axis head. There are four USB 2.0 sockets, two 12V power sockets and an ST-4 autoguiding port. Connections to a computer and 12V supply are on the panel surrounding the polarscope.

SPRING-LOADED SADDLE CLAMP

The saddle clamp is compatible with both the standard Vixen and the larger Losmandy styles of dovetail bar. A generous 114mm clamping section ensures a firm but non-marring attachment for your telescope. Twin spring-loaded hand bolts allow easy tightening even when wearing gloves.

GEAR SYSTEM

To minimise any backlash in the worm gear drive system, the CEM 60 uses a magnetically loaded gear system to maintain a constant mesh. An unusual clutch mechanism comprised of a small adjustment knob allows for free rotation of each axis for balancing purposes, but a solid engagement when locked.

HAND CONTROLLER

The Go2Nova 8407 hand controller has a generous eight-line display and integrated temperature control. With a database in excess of 358,000 objects – including Solar System, NGC, Messier, Caldwell, Herschel 400, UGC, IC, GCVS, Abell, binary stars and the SAO catalogue – there's no shortage of objects on offer.

ALTITUDE ADJUSTMENT

Altitude adjustment, which must be carried out to ensure an accurate polar alignment, uses a geared quadrant driven by a worm screw. We found this very easy to adjust and much simpler than the usual opposing bolt method adopted in many other mounts. Two locking capstans clamp the mount firmly in position.

ALL PHOTOS: WWW.THESECRETSTUDIO.NET

Revelation 10-inch M-CRF Premium Dobsonian

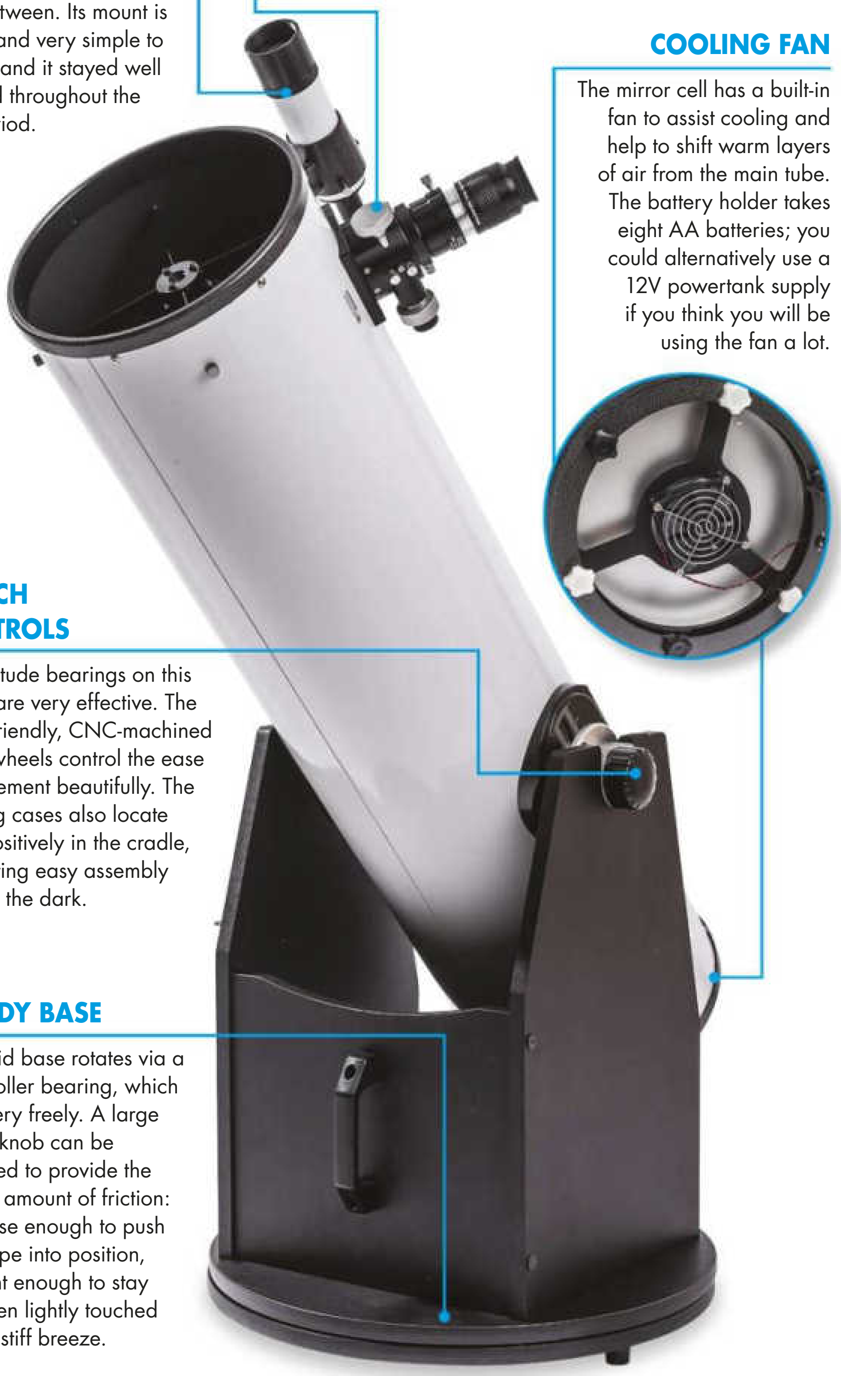
An easy to use telescope that isn't just for beginners

Revelation has taken a classic design – a rolled steel tube, a simple Dobsonian mount and a large parabolic mirror – and finessed it. Completing the system are a 1.25-inch 9mm Plössl eyepiece, a 2-inch 30mm Superview eyepiece, an 8x50 finderscope and an eyepiece rack.

The beauty of this type of mount lies in the speed of setup and simplicity of use. The large mirror does need time to cool down, but a battery-operated fan is built in to speed up the process.

A 10-inch telescope gathers 56 per cent more light than an 8-inch instrument, making visual observations of relatively faint deep-sky targets a breeze. With the 30mm eyepiece we enjoyed beautiful star clusters such as the Beehive in Cancer (see p48). With so many more visible stars than are possible in a small refractor, this certainly produced the elusive 'wow factor'. Moving on to the planets with the higher-powered 9mm eyepiece, we saw good colour variation on Jupiter and some detail within the belts, as well as the four Galilean moons. Mars was very rewarding: although not quite at opposition it was still easy to define the larger surface features and polar cap. Lunar views were good too, with excellent contrast across the surface as well as around the terminator.

Being a manual Dobsonian without tracking means keeping your eyepiece on the target at high magnification requires some skill. Nonetheless, this 10-inch instrument is delightfully simple to use, and provides a serious amount of aperture and high quality observing for beginners and advanced astronomers alike.



FINDERSCOPE

The finder has 8x50 optics and a traditional crosshair reticule, offering a view the same way up as the main scope and revealing plenty of faint stars to hop between. Its mount is sturdy and very simple to adjust, and it stayed well aligned throughout the test period.

SMOOTH FOCUSING

The very chunky, well-engineered, 10:1 dual-speed Crayford-style focuser is provided with an adaptor that allows you to use either 2- or 1.25-inch eyepieces and accessories. Thumbscrews provide friction adjustment, while the locking facility makes it a pleasure to use, with smooth, fine movements and no backlash.

COOLING FAN

The mirror cell has a built-in fan to assist cooling and help to shift warm layers of air from the main tube. The battery holder takes eight AA batteries; you could alternatively use a 12V powertank supply if you think you will be using the fan a lot.

CLUTCH CONTROLS

The altitude bearings on this scope are very effective. The glove-friendly, CNC-machined metal wheels control the ease of movement beautifully. The bearing cases also locate very positively in the cradle, facilitating easy assembly even in the dark.

STURDY BASE

The rigid base rotates via a large roller bearing, which turns very freely. A large plastic knob can be tightened to provide the perfect amount of friction: just loose enough to push the scope into position, but tight enough to stay put when lightly touched or in a stiff breeze.

VITAL STATISTICS

- **Price** £478
- **Optics** BK7 optical glass parabolic primary mirror
- **Aperture** 250mm (10 inches)
- **Focal length**: 1,250mm (f/5)
- **Focuser** Dual-speed 10:1, 2-inch, Crayford-style
- **Extras** 1.25-inch 9mm Plössl and 2-inch 30mm Superview eyepieces, 8x50 finder, eyepiece rack
- **Weight** 16.5kg (tube only)
- **Supplier** Telescope House, www.telescopehouse.com, 01342 837098

VERDICT ★★★★☆

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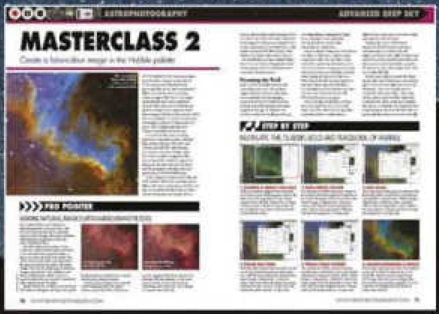

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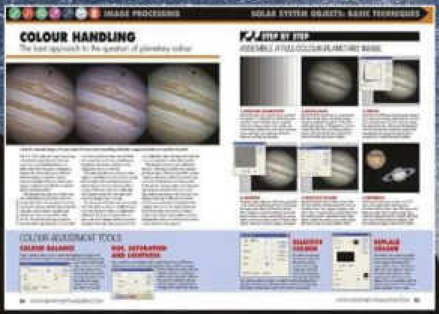

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2016 Month by month GUIDE

12 MONTHLY Star Charts

What to see in the night sky throughout the year

by **Pete Lawrence**

JANUARY 36
Enjoy a naked-eye comet and the Quadrantid meteor shower

FEBRUARY 40
Plenty to see in the sky as spring starts to make its presence felt

MARCH 44
The Moon gets close to three planets as the nights shorten

APRIL 50
Look out for close passes between the Moon and planets all month

MAY 54
A transit of Mercury is the main event this month

JUNE 58
The summer solstice and short nights see Saturn at opposition

JULY 64
Venus and Mercury get close on the warm summer nights

AUGUST 68
Darker skies see meteors and close planetary passes

SEPTEMBER 72
The nights cool and lengthen, and there's lots to see

OCTOBER 78
Autumn constellations take centre stage and Orionids put on a show

NOVEMBER 82
Dramatic constellations take over the skies as the nights grow cold

DECEMBER 86
Watch out for two meteor showers on this month's long chilly nights

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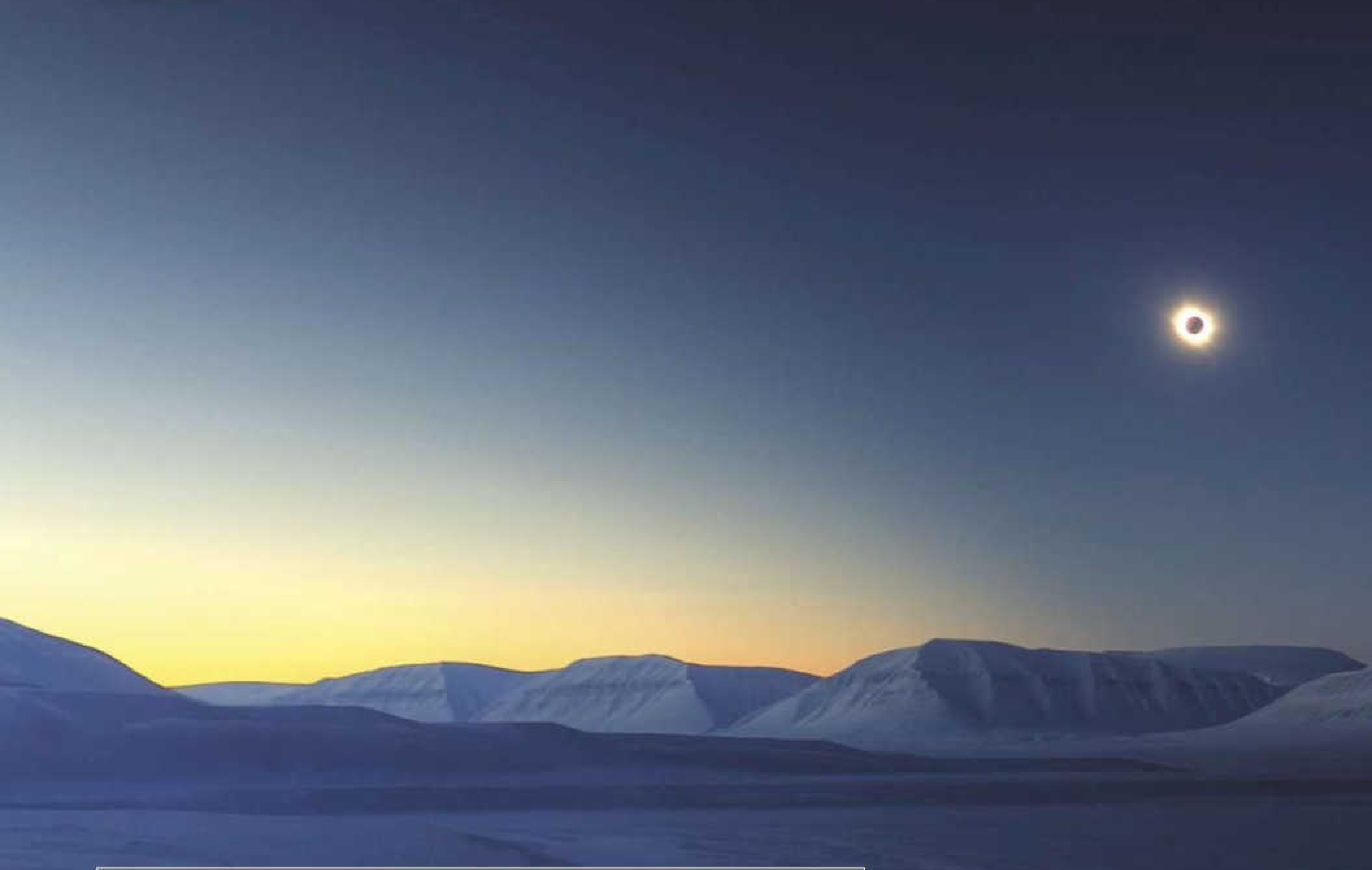
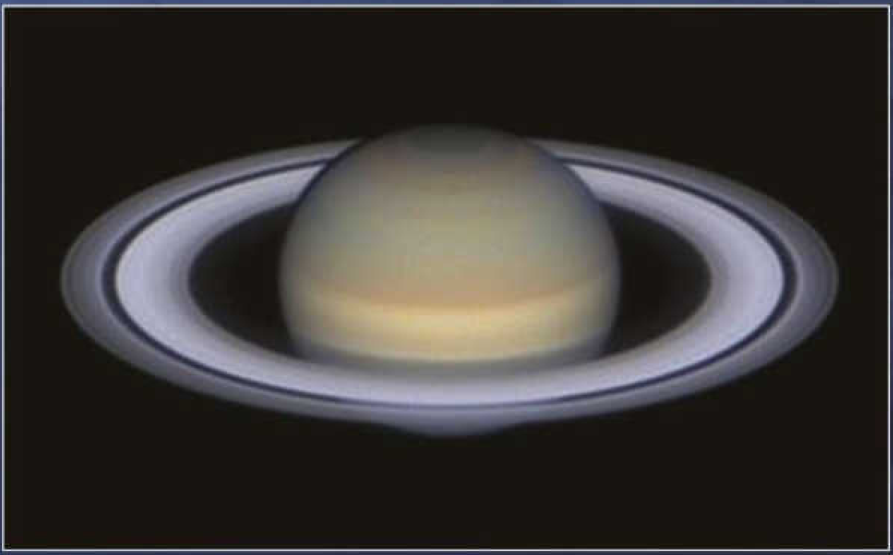


Eclipse Totality over Sassendalen

Luc Jamet, France



◀ RUNNER UP
PLANETS, COMETS AND ASTEROIDS

Saturn

András Papp, Hungary

January

Enjoy a naked-eye comet and the Quadrantid meteor shower this month

KEY DATES

1 JANUARY
Potentially fourth magnitude comet C/2013 US10 Catalina is 40 arcminutes from Arcturus, visible in the morning sky

4 JANUARY
The Quadrantid meteor shower reaches its peak this morning

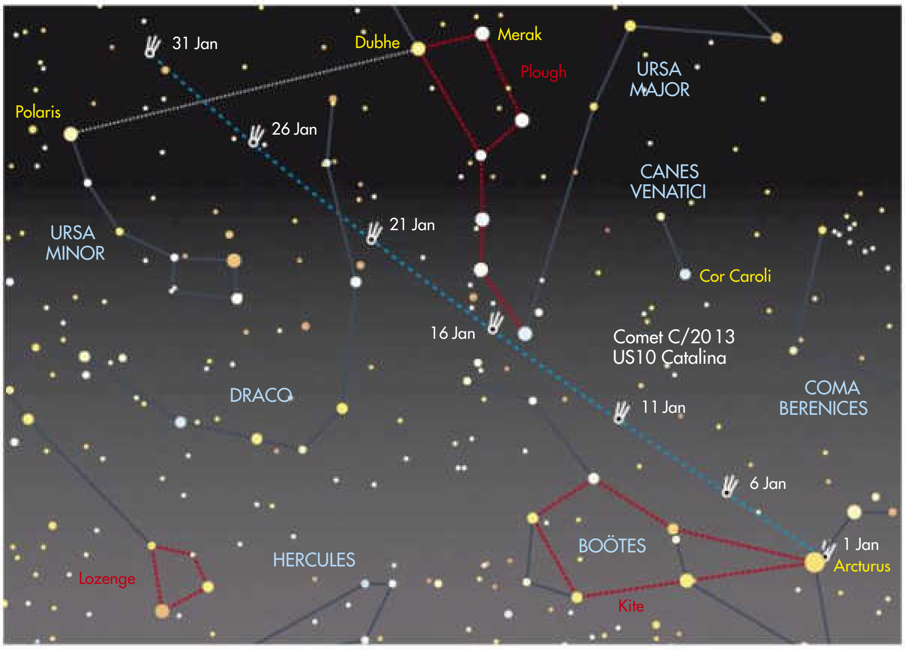
7 JANUARY
Venus, Saturn and an 8% lit waning crescent Moon form a right-angled triangle, low in the southeast before dawn

9 JANUARY
Venus and Saturn appear less than 7 arcminutes apart this morning

20 JANUARY
The Moon occults the bright star Aldebaran between 03:23 and 03:57 UT (as seen from the centre of the UK)

JANUARY at a glance

Watch out for comet Catalina heading north in the mornings



Comet C/2013 US10 Catalina should be visible to the naked eye throughout the month

As we ring in 2016, the winter night sky provides reassuring continuity. The view to the south, early in the evening, shows the subtlety of the autumn sky gracefully exiting west. As proper darkness falls, the main constellation to the south is Cetus, bookended by two reasonably bright stars: mag. +2.0 Deneb Kaitos (Beta (β) Ceti) or to the west and mag. +2.5 Menkar (Alpha (α) Ceti) to the east. Above Cetus lies Pisces, best identified from the circle of dim stars known as the Circlet.

North of the Circlet is the Great Square of Pegasus, one of the defining shapes of autumn and key to locating the Andromeda Galaxy. Andromeda is represented by a wedge of stars emanating out of the northeast star in the Great Square and the galaxy lies north of its centre. East of the Square lie the small constellations of Aries and Triangulum.

The Pleiades open cluster is prominent further to the east before midnight. The cluster marks the shoulder of Taurus the Bull. His head is represented by a V of stars known as the Hyades, with mag. +0.8 Aldebaran (Alpha (α) Tauri) as his eye.

Southeast of Taurus is mighty Orion, the winter constellation that takes centre stage in the run up to midnight. His seven main bright stars are easy to pick out, and binoculars or a telescope will show the jewel in his sword, the Orion Nebula, M42.

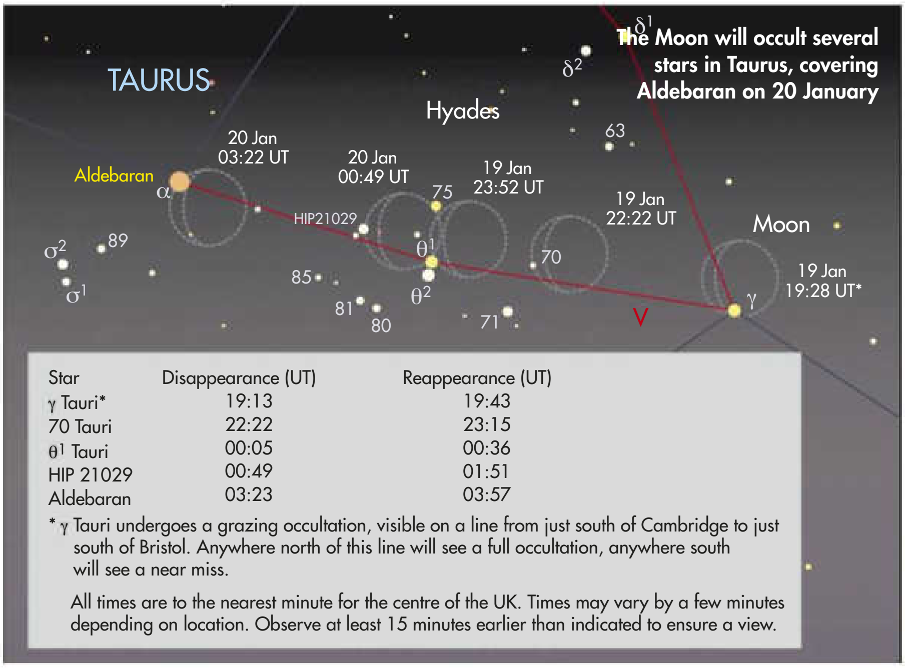
Dog days

Follow Orion's belt southeast to locate the brightest star in the night sky, mag. -1.5 Sirius (Alpha (α) Canis Majoris). This is part of Canis Major, the Great Dog. To the northeast is mag. +0.4 Procyon (Alpha (α) Canis Minoris) the brightest star in Canis Minor, the Little Dog. A line between Betelgeuse in Orion, Sirius and Procyon defines the Winter Triangle.

Extend a line from mag. +0.2 Rigel (Beta (β) Orionis) at Orion's southwest corner, through mag. +0.4 Betelgeuse (Alpha (α) Orionis) for about twice the distance again, and you'll arrive at the twin stars of mag. +1.6 Castor (Alpha (α) Geminorum) and mag. +1.2 Pollux (Beta (β) Geminorum), the brightest in Gemini. Southerly Pollux is slightly brighter and redder than Castor. To the east of Gemini lie the spring constellations of Cancer, Leo (where you'll find Jupiter) and Hydra.

The Quadrantid meteors reach their peak early in the morning on 4 January. Look for the triangle of the waning crescent Moon, Venus and Saturn on the morning of 7 January. On the 9th, Venus and Saturn will appear slightly less than one-quarter the apparent diameter of the Moon apart.

Finally, there should be a real treat in the form of a naked-eye comet, C/2013 US10 Catalina. The comet is currently heading north, up the sky. It'll be easy to locate on the morning of 1 January, close to the bright orange mag. +0.0 Alpha (α) Boötis or Arcturus in Boötes.



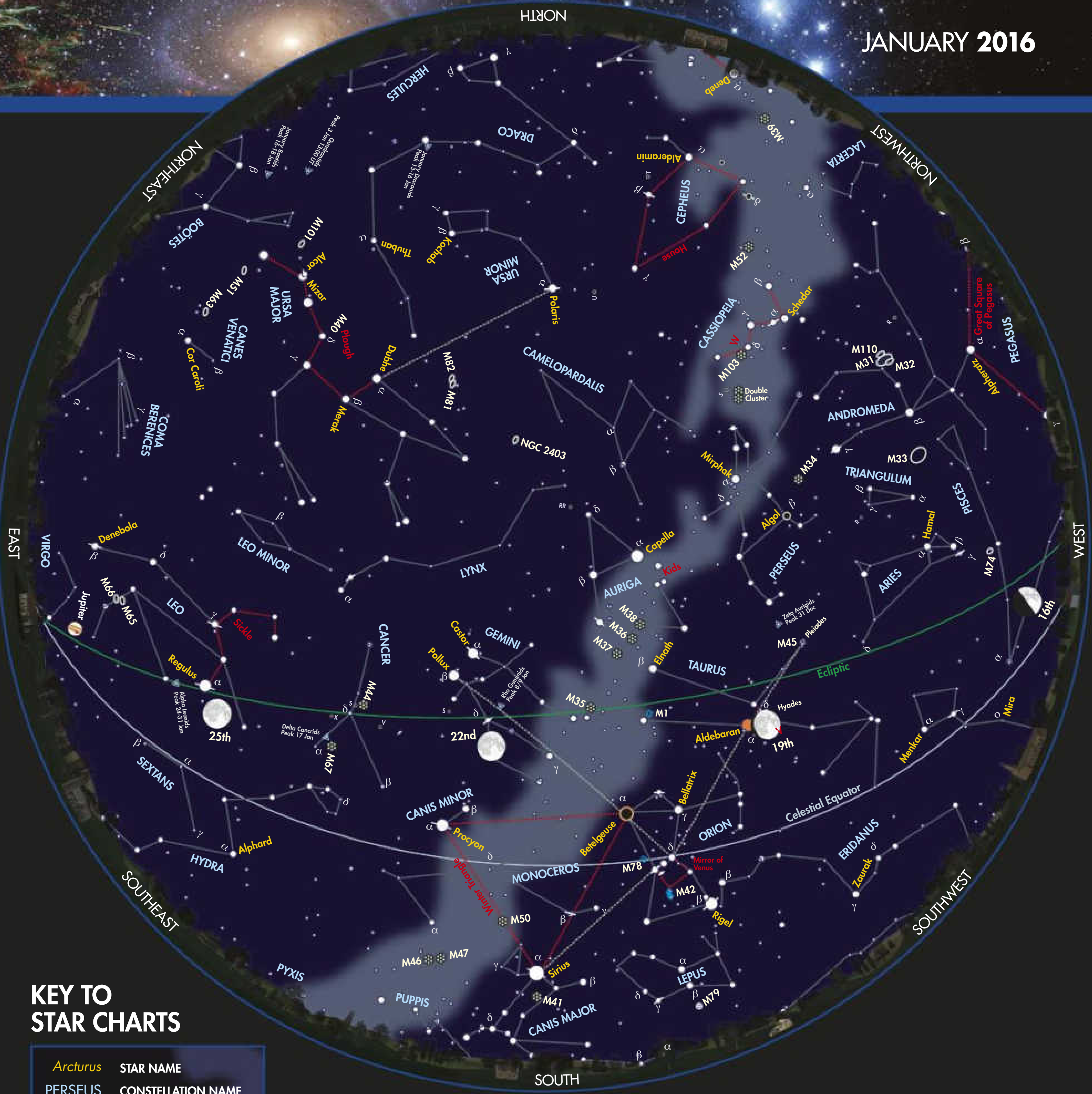
The Moon will occult several stars in Taurus, covering Aldebaran on 20 January

Star	Disappearance (UT)	Reappearance (UT)
γ Tauri*	19:13	19:43
70 Tauri	22:22	23:15
θ1 Tauri	00:05	00:36
HIP 21029	00:49	01:51
Aldebaran	03:23	03:57

* γ Tauri undergoes a grazing occultation, visible on a line from just south of Cambridge to just south of Bristol. Anywhere north of this line will see a full occultation, anywhere south will see a near miss.

All times are to the nearest minute for the centre of the UK. Times may vary by a few minutes depending on location. Observe at least 15 minutes earlier than indicated to ensure a view.

PETE LAWRENCE X 3



KEY TO STAR CHARTS

Arcturus	STAR NAME
PERSEUS	CONSTELLATION NAME
⬭	GALAXY
◌ ❋	OPEN CLUSTER
⊕	GLOBULAR CLUSTER
	PLANETARY NEBULA
□	DIFFUSE NEBULOSITY
	DOUBLE STAR
○	VARIABLE STAR
◐	THE MOON (SHOWING PHASE)
	COMET TRACK
	ASTEROID TRACK
	STAR-HOPPING PATH
△	METEOR RADIANT
Circlet	ASTERISM
←	MILKY WAY
	PLANET

STAR BRIGHTNESS:

MAG. 0 & BRIGHTER ● MAG. +1 ● MAG. +2 • MAG. +3 • MAG. +4 & FAINTER ·

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Evening object at the start of January, but a morning object close to Venus by month end

VENUS
Morning object, best at the start of the month. Very close to Saturn on 9 January

MARS
Mars is in the morning sky, reaching its highest point, due south, as the sky begins to brighten

JUPITER
Another morning planet. Reaches its highest point, due south, at 03:00 UT by the 31st

SATURN
Saturn is in Ophiuchus, visible low in the southeast before dawn. Best at the end of the month

URANUS
Evening planet, best seen at the start of January, two degrees below Epsilon (ε) Piscium

NEPTUNE
Evening planet in Aquarius, best seen at the start of January

MOON PHASES Key stages in the monthly cycle

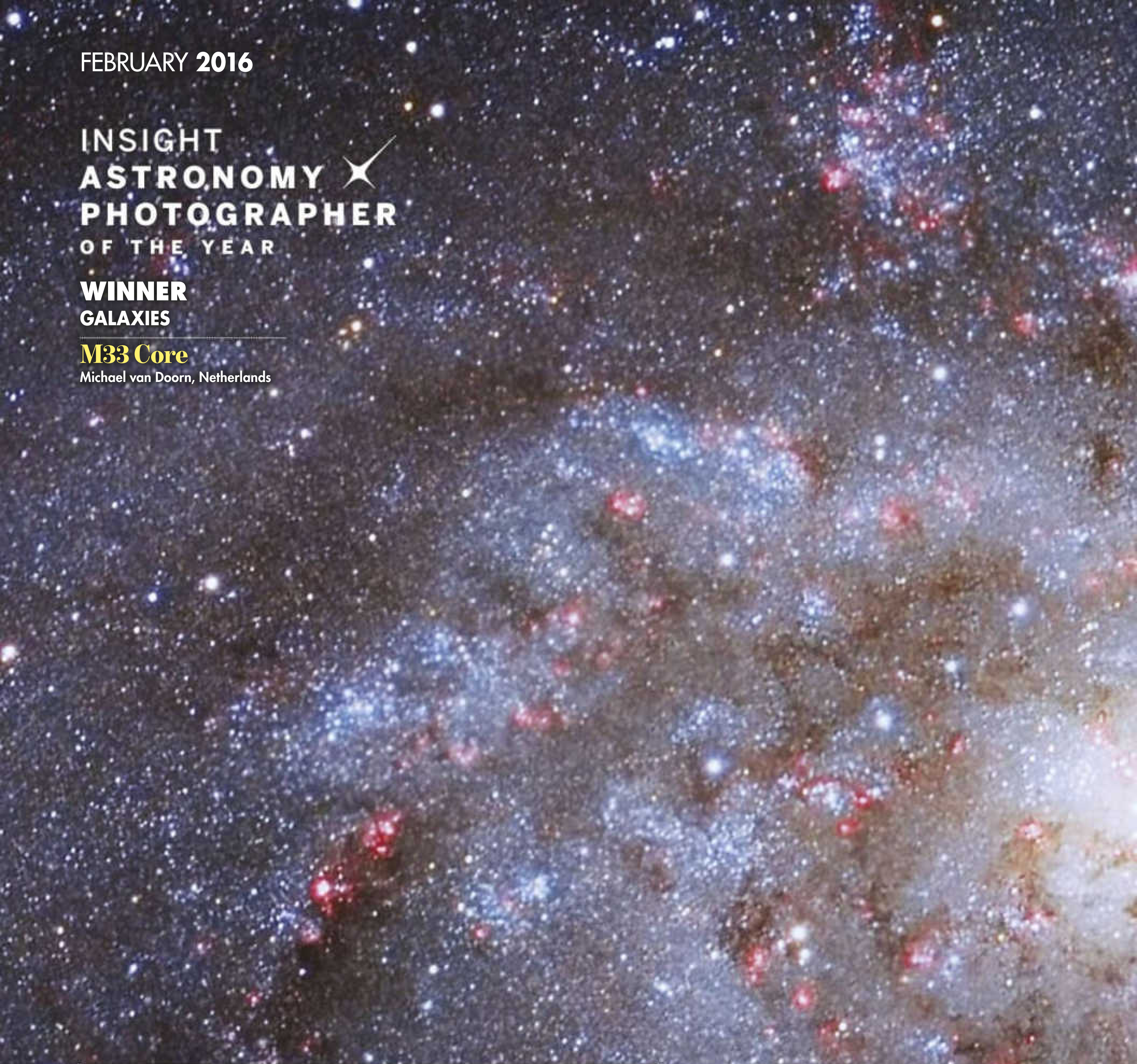
LAST QUARTER MOON
2 Jan

NEW MOON
10 Jan

FIRST QUARTER MOON
16 Jan

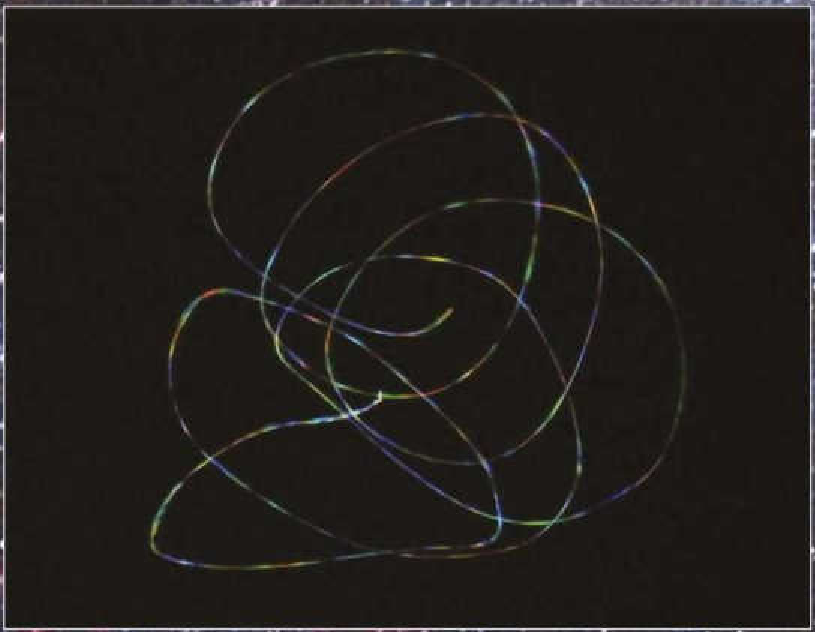
FULL MOON
24 Jan

INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR



WINNER
GALAXIES

M33 Core
Michael van Doorn, Netherlands



◀ RUNNER UP
STARS & NEBULAE (JOINT RUNNER UP)

Sirius 9798
David Pye, UK

February

Plenty to see in the sky as spring starts to make its presence felt

KEY DATES

6 FEBRUARY
Mag. –3.9 Venus, 0.0 Mercury and a 6% waning crescent Moon form a distinctive triangle in the early morning sky

9 FEBRUARY
A thin 1% waxing crescent Moon may be spotted just after sunset

16 FEBRUARY
The 57% waxing gibbous Moon occults the star Gamma Tauri at around 01:45 UT

24 FEBRUARY
Jupiter and the full Moon are just 2° apart at 02:40 UT

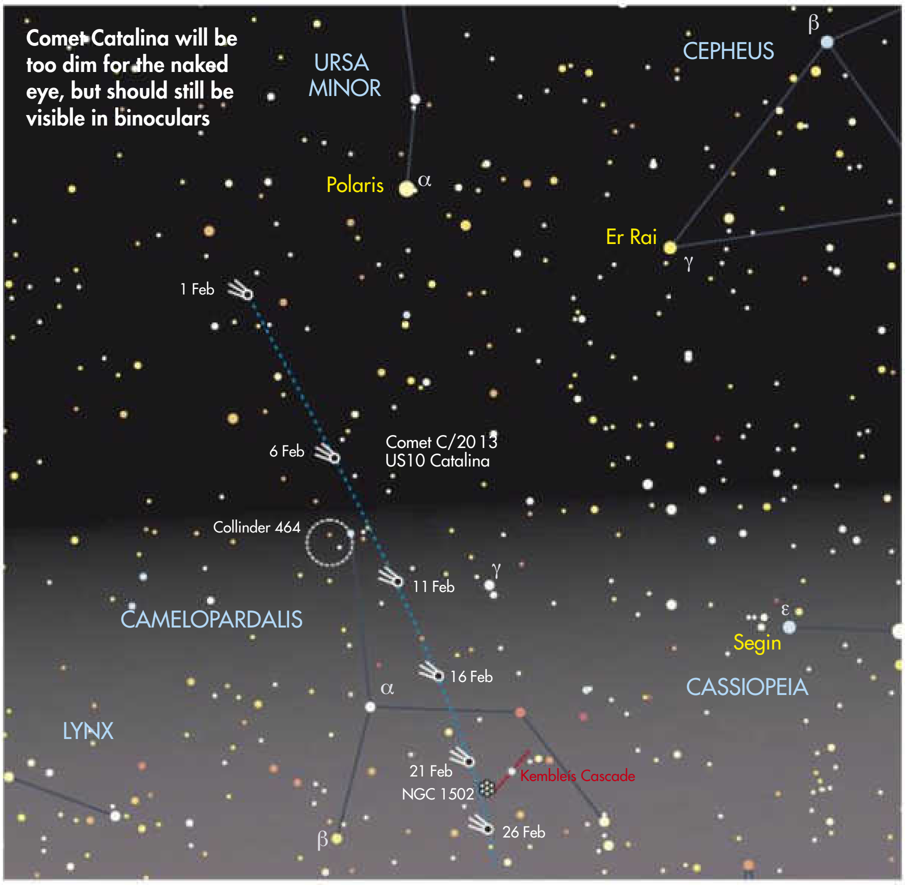
22 FEBRUARY
Eighth magnitude comet C/2013 US10 Catalina passes NGC 1502 at the eastern end of Kemble's Cascade this evening

FEBRUARY at a glance

Bright planets in the morning sky as the nights begin to shorten

February is a transitional month as far as the sky is concerned. The low southerly aspect of the Sun is now changing as it starts to move ever quicker north. This affects the length of night and appears to accelerate the demise of winter's dramatic stars. You still have time to enjoy Orion and Taurus but by the end of the month, they are at their highest point in the sky, due south, as the sky is darkening.

South of Gemini is bright mag. +0.4 Procyon (Alpha (α) Canis Minoris) the main star in Canis Minor, the Little Dog. South of this is the brightest star in the entire night sky, mag. –1.5 Sirius (Alpha (α) Canis Majoris). A triangle formed by joining the dots of mag. +0.4 Betelgeuse (Alpha (α) Orionis), Sirius and Procyon is known as the Winter Triangle. The winter Milky Way passes close to Betelgeuse and down through the triangle. Here, using a pair of binoculars, you'll find many rich open clusters of stars. These pepper the faint constellation of Monoceros which crosses into the triangle from the east.



Comet Catalina will be too dim for the naked eye, but should still be visible in binoculars

Big cats of the sky

Early evening in the east-southeast, the majestic outline of Leo, the Lion, can be seen creeping higher in the sky. Currently, the lion's back paw is highlighted by the presence of bright Jupiter. The brightest star in Leo is mag. +1.3 Regulus (Alpha (α) Leonis), and this sits at the bottom of a distinctive backward question mark pattern known as the Sickle.

The Beehive Cluster, M44 (see p48) sits south of the mid-point between Regulus and mag. +1.6 Castor (Alpha (α) Geminorum). It's fairly easy to spot in a dark sky but can be lost in light pollution. Binoculars show it really well.

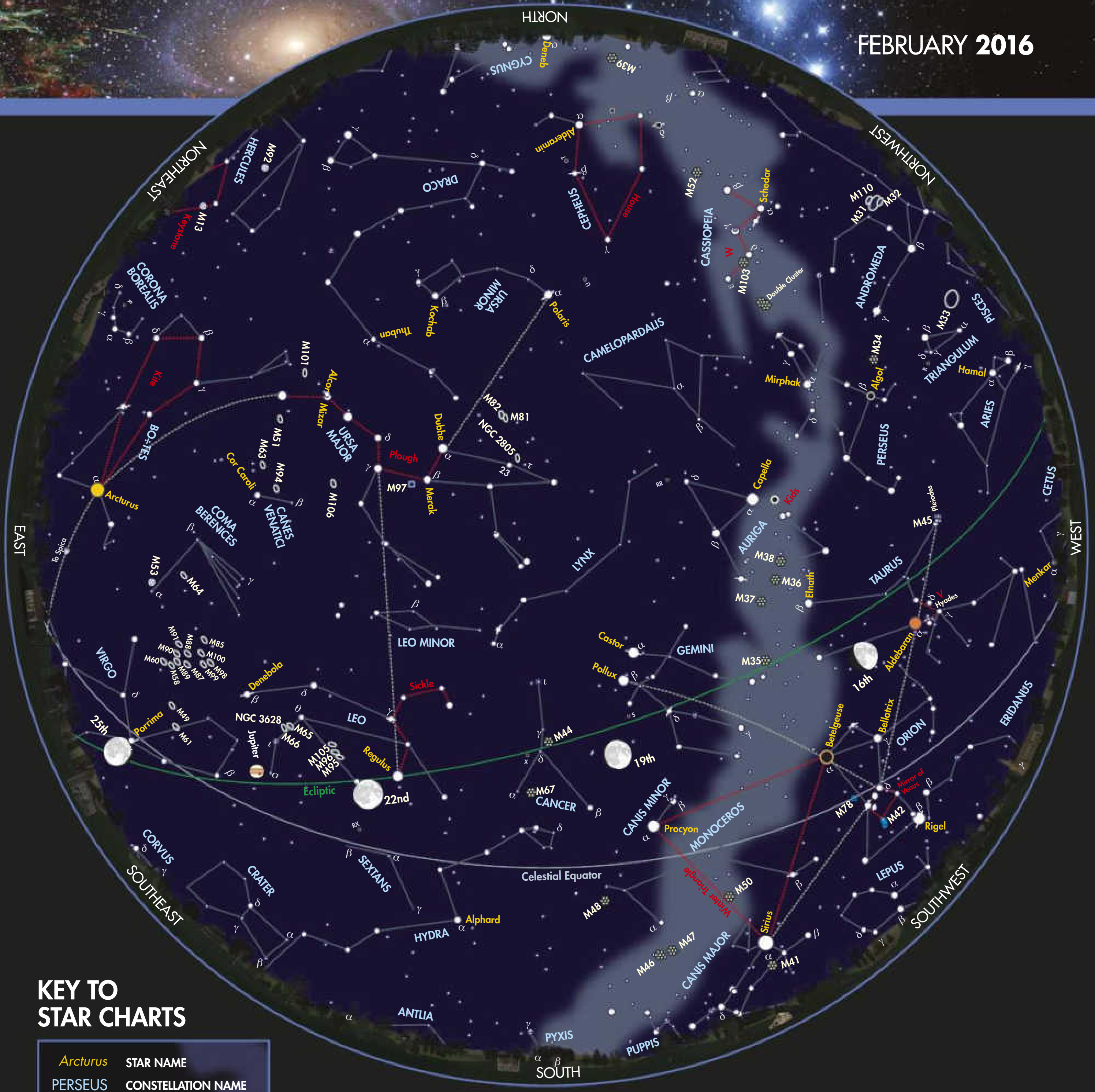
M44 is at the heart of the faint, inverted-Y constellation of Cancer which marks the start of the spring sky and is bordered above and below by faint, indistinct patterns. To the south is a sideways teardrop representing the head of Hydra, the Watersnake. The rest of the constellation meanders off to the south and east, taking an age to rise completely.

Above Cancer is the faint constellation of Lynx. It's so indistinct that the Polish astronomer Johannes Hevelius stated that you'd need to have eyes like a Lynx to see it! The brightest star in Lynx, mag. +3.1 Alpha (α) Lyncis, is also its most southerly. To the east of Alpha Lyncis is Leo Minoris and above this Ursa Major, the Great Bear, containing perhaps the most widely recognised pattern in the entire night sky, the asterism known as the Plough.

Many of the brighter planets can be found in the morning sky and there's a lovely coming together of Mercury, Venus and a 6% lit waning crescent Moon on 6 February. Comet C/2013 Catalina will have faded enough to require binoculars or a small telescope to see. On 22 February, the comet passes really close to the star cluster NGC 1502 which lies at the end of a faint line of stars known as Kemble's Cascade. This should be a very photogenic event.

Kemble's Cascade is an asterism in Camelopardalis

PETE LAWRENCE X 3



KEY TO STAR CHARTS

Arcturus	STAR NAME
PERSEUS	CONSTELLATION NAME
⬭	GALAXY
◌ ❄	OPEN CLUSTER
⊕	GLOBULAR CLUSTER
⌖	PLANETARY NEBULA
□	DIFFUSE NEBULOSITY
●	DOUBLE STAR
○	VARIABLE STAR
◐	THE MOON (SHOWING PHASE)
☄	COMET TRACK
☄	ASTEROID TRACK
⋯	STAR-HOPPING PATH
△	METEOR RADIANT
Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

MAG. 0 & BRIGHTER ● MAG. +1 ● MAG. +2 • MAG. +3 • MAG. +4 & FAINTER ·

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Low in the southeast in the morning dawn twilight, best at the start of the month

VENUS
Morning object, close to southeast horizon before sunrise. Best seen at the end of February

MARS
Morning planet travelling east through Libra during February. Best seen at the end of the month

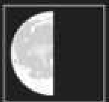
JUPITER
Morning planet. Reaches its highest point in the sky, due south, in darkness all month

SATURN
Best at the end of the month, reaching its highest point, south-southeast in Ophiuchus, at 05:00 UT

URANUS
Visible all month in the evening sky but losing altitude towards the end of February

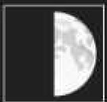
NEPTUNE
In conjunction with the Sun on 28 February and not visible this month

MOON PHASES Key stages in the monthly cycle

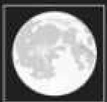


LAST QUARTER MOON
1 Feb

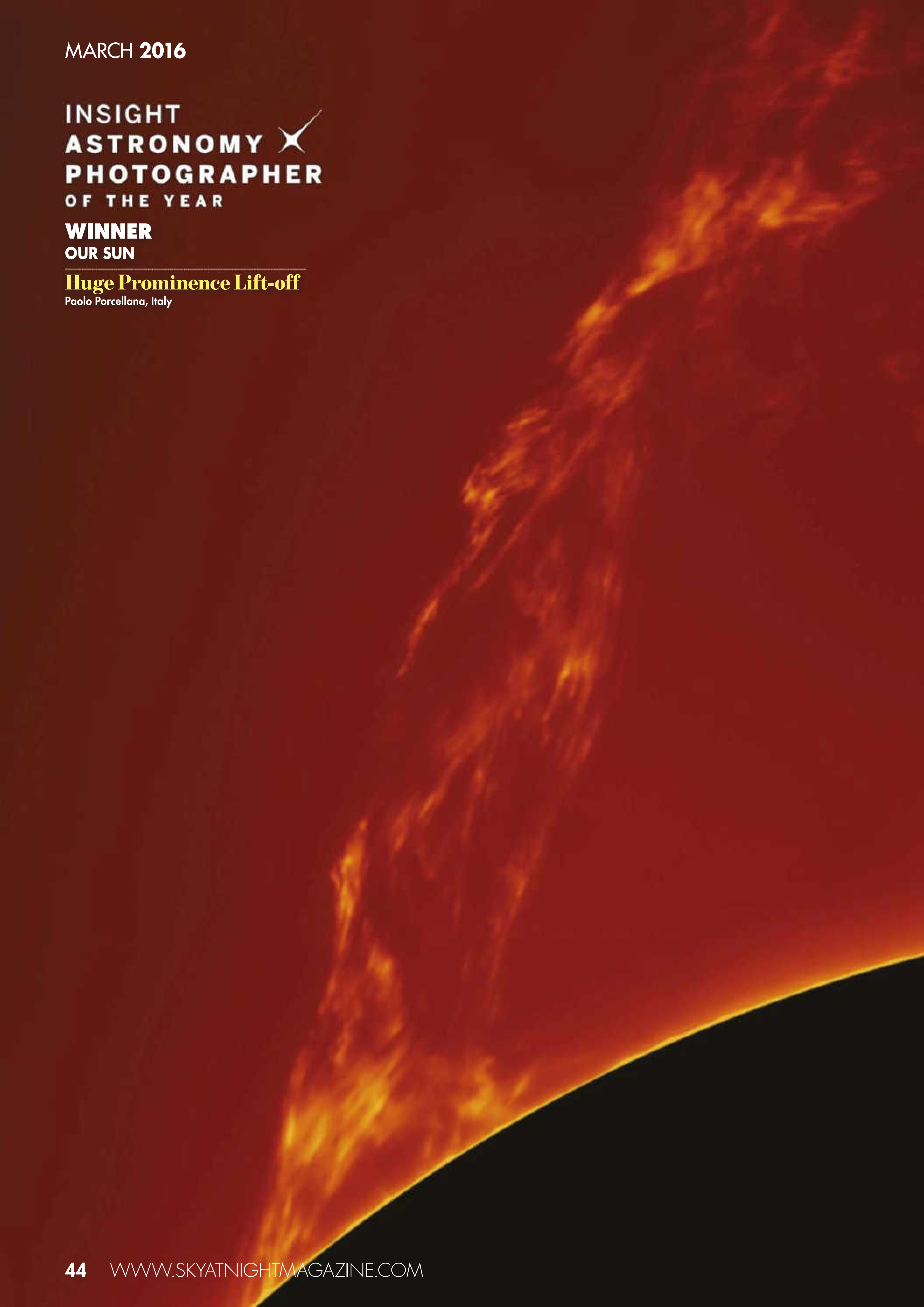
NEW MOON
8 Feb



FIRST QUARTER MOON
15 Feb



FULL MOON
22 Feb



INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

WINNER
OUR SUN

Huge Prominence Lift-off

Paolo Porcellana, Italy

March

The Moon gets close to three planets as the nights shorten

KEY DATES

1 MARCH
The 58% waning gibbous Moon is 5° from Mars at 02:20 UT, low in the southeast

7 MARCH
Venus and the 4% waning crescent Moon are 2.75° apart at 06:20 UT, low in the south-southeast

8 MARCH
Magnificent Jupiter reaches opposition and is now at its best for the year

9 MARCH
Possibility of seeing an incredibly thin, 16-hour Moon just after sunset

20 MARCH
The rate of change in the length of day and night peaks as Earth passes through an equinox

▼RUNNER UP

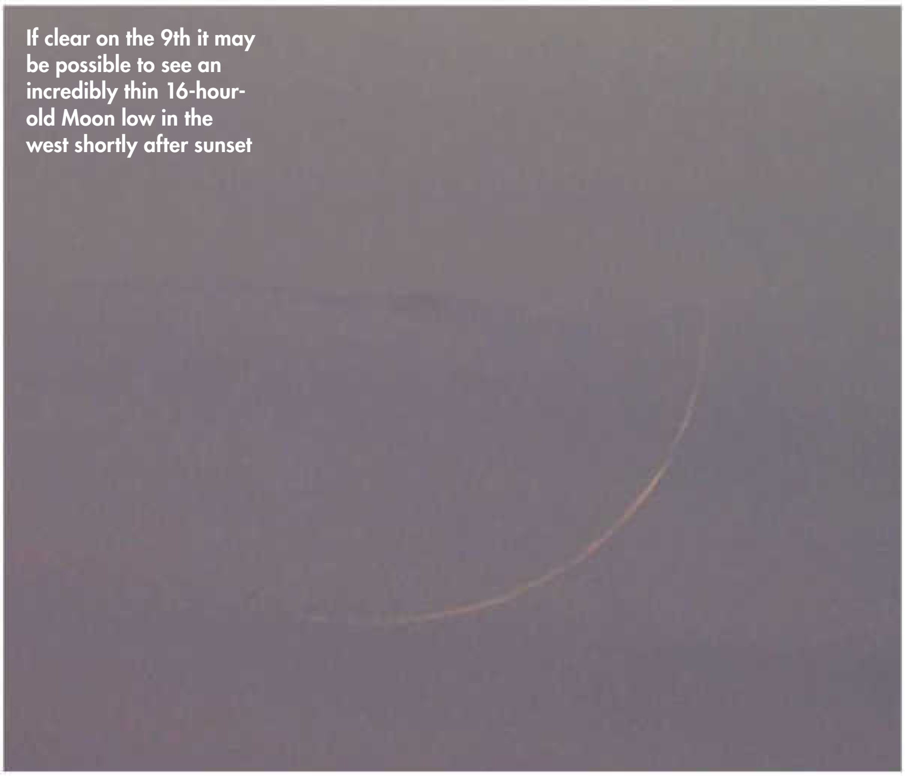
AURORAE

April Aurora

Kolbein Svensson, Norway

MARCH at a glance

The night sky is filled with animals as we approach spring equinox



If clear on the 9th it may be possible to see an incredibly thin 16-hour-old Moon low in the west shortly after sunset

The apparent speed at which the day lengthens and the night shortens reaches a peak this month as the Northern Hemisphere approaches its spring equinox. The Sun's change in declination is increasing at its fastest for the year; in other words, the Sun's apparent movement north is at its fastest rate.

The effect of this on the constellations is very evident. Magnificent Orion remains prominent at the start of March, and is close to its highest position, due south, as darkness falls. However, by the time the sky gets dark on 31 March, Orion is much lower in the southwest part of the sky.

As Orion slips from prime position, Leo is ready to take its place. This is a very distinctive pattern of stars, but in case you have trouble finding it look virtually overhead where you'll find the Plough or Saucepan asterism. Assuming you see it as a saucepan, extend the line made by the two stars in the pan closest to the handle downwards and you'll arrive at bright mag. +1.3 Regulus (Alpha (α) Leonis).

Regulus sits at the bottom of a backward question mark pattern of stars known as the Sickle; again a distinctive and easy to recognise pattern. If you have any doubt about the location of Leo, bright Jupiter lights the way close to the lion's back foot.

To the west of Leo is the faint inverted Y-shaped constellation of Cancer the Crab. Below this is a faint, sideways teardrop pattern of stars which represents the head of Hydra, the Watersnake. With care it is possible to trace the body of the watersnake south and east of the head, but it takes patience to do this, as many of the stars here are faint. One exception is mag. +2.0 Alphard (Alpha (α) Hydrae), 'the solitary one', the brightest star in Hydra and located in a region of the sky devoid of much else. Alphard can be seen south and slightly west of Regulus.

Sluggish snake

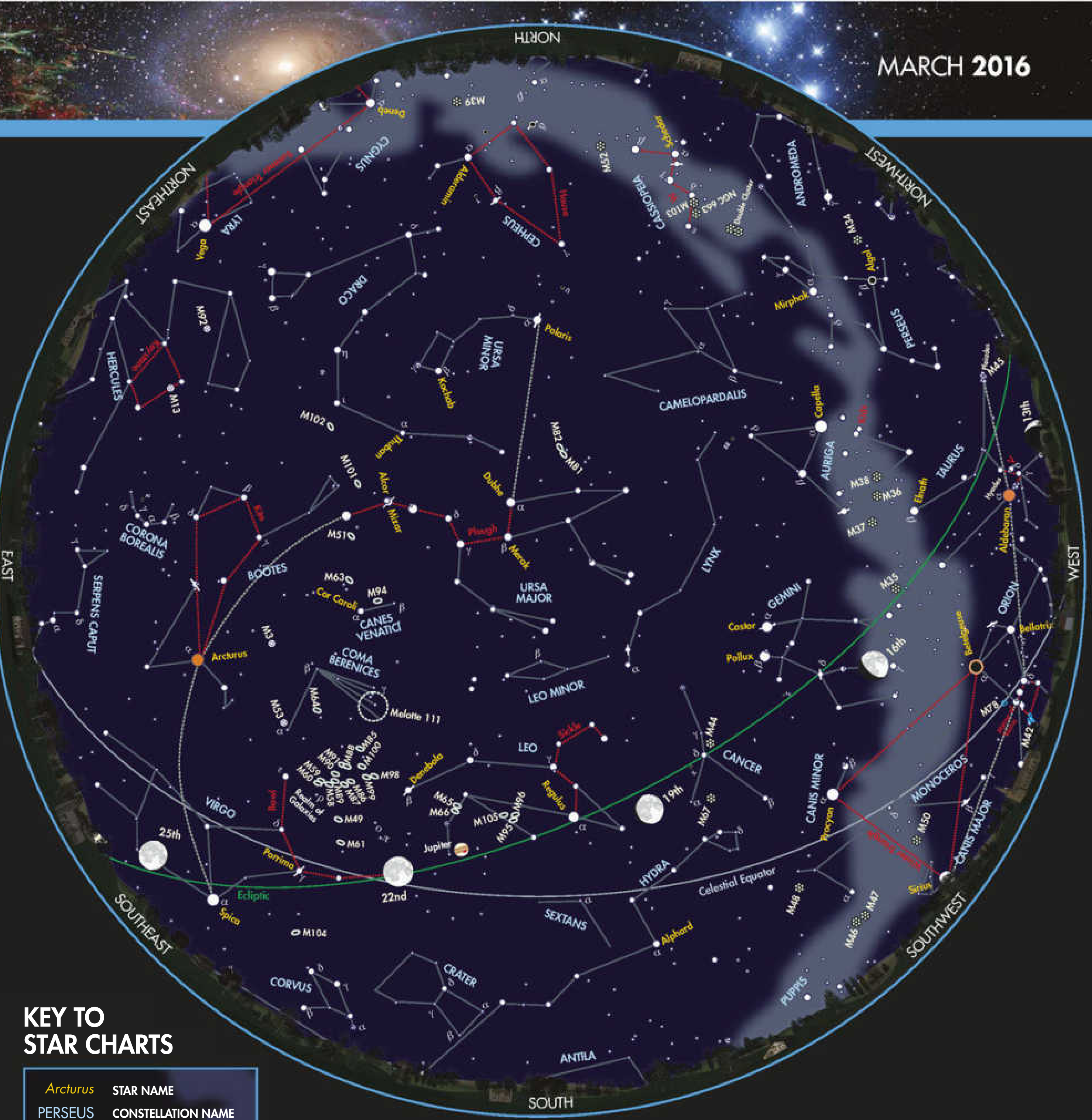
Hydra is the largest constellation in the entire sky and, from the UK, takes an amazing 11 hours to rise. It also carries with it some smaller constellations in the form of Sextans, Crater and Corvus. Of these, the eastern-most Corvus, representing a mythological crow, is the most distinctive. Its small quadrilateral shape is sometimes referred to as the Sail.

To the east of mag. +2.1 Denebola (Beta (β) Leonis), representing the tail of Leo, is a faint smattering of stars best seen in dark skies. This is Coma Berenices, or Queen Berenices's Hair. It gets its hair-like shimmering effect from the large triangular cluster known as Melotte 111 (see p62). Southeast of Leo is the second largest constellation in the night sky, Virgo – a sprawling patch of sky highlighted by bright white Spica and a large bowl-shaped pattern of stars southeast of Denebola.

Return to the Saucepan and follow the handle away from the pan to arrive at the brightest star in the northern half of the night sky, mag. –0.1 Arcturus (Alpha (α) Boötis). Its brilliant orange glow is quite amazing on a dark night. Continue the arc through Arcturus and you'll arrive at mag. +1.0 Spica (Alpha (α) Virginis).

Jupiter is at opposition on 8 March and forms a close pair with the full Moon on the 22nd

PETE LAWRENCE X 3



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☄	COMET TRACK
☄	ASTEROID TRACK
┄	STAR-HOPPING PATH
△	METEOR RADIANT
Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

●	●	•	·	·
MAG. 0 & BRIGHTER	MAG. +1	MAG. +2	MAG. +3	MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Not visible until the end of the month (evening sky) as it rises at the same time as the Sun

VENUS
Poorly placed because it'll be very close to the horizon as the Sun rises all month

MARS
Low in Scorpius and growing from around 8.5 arcseconds to over 12 arcseconds by month's end

JUPITER
At opposition on 8 March. Currently located close to the back paw of Leo the Lion, Sigma Leonis

SATURN
Saturn is a morning object almost culminating in darkness at the end of the month

URANUS
Uranus is visible at the start of the month but rapidly loses its position to the evening twilight by the end

NEPTUNE
Not visible this month

MOON PHASES Key stages in the monthly cycle

LAST QUARTER MOON
1 Mar

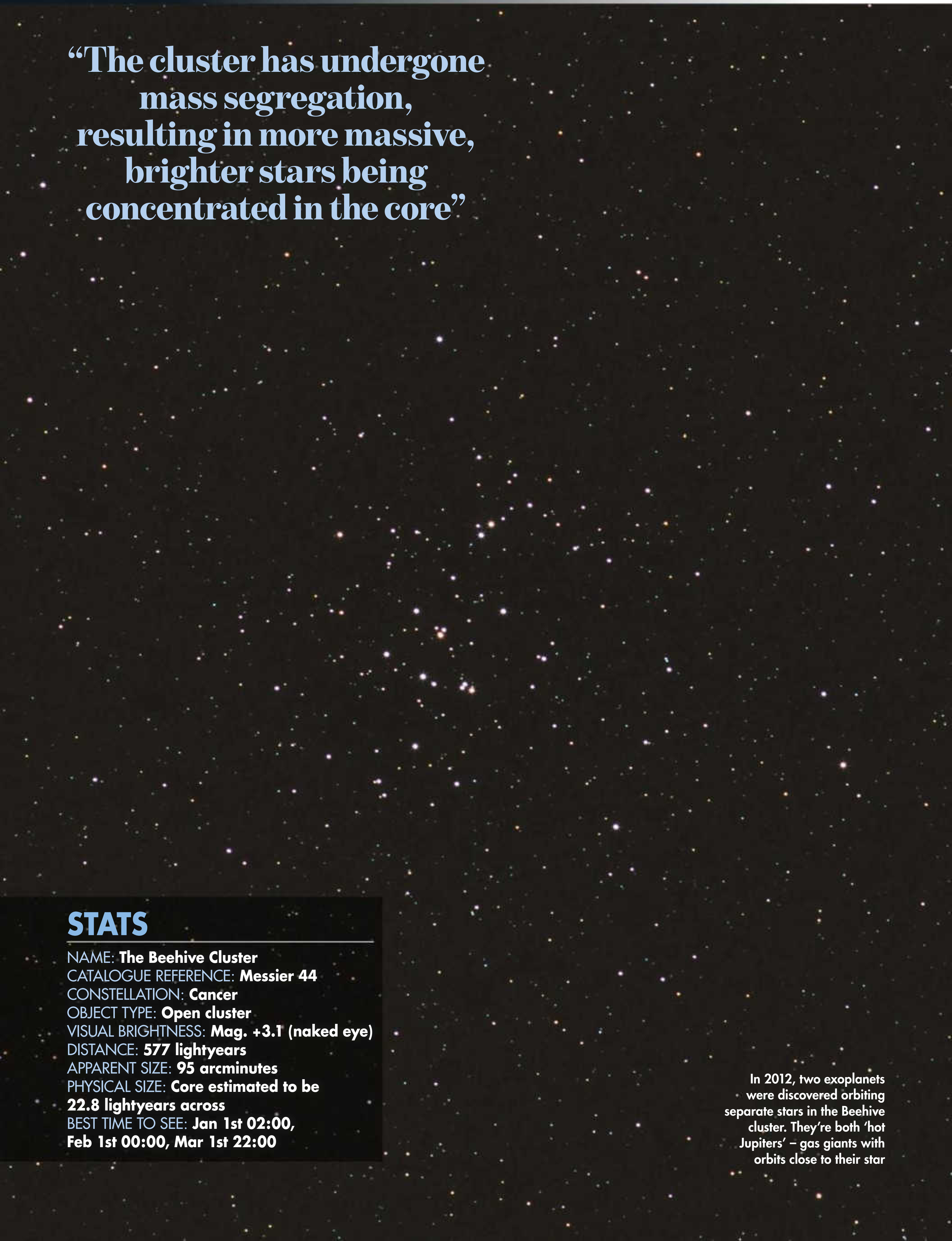
NEW MOON
9 Mar

FIRST QUARTER MOON
15 Mar

FULL MOON
23 Mar

LAST QUARTER MOON
31 Mar

> “The cluster has undergone mass segregation, resulting in more massive, brighter stars being concentrated in the core”



STATS

NAME: **The Beehive Cluster**
CATALOGUE REFERENCE: **Messier 44**
CONSTELLATION: **Cancer**
OBJECT TYPE: **Open cluster**
VISUAL BRIGHTNESS: **Mag. +3.1 (naked eye)**
DISTANCE: **577 lightyears**
APPARENT SIZE: **95 arcminutes**
PHYSICAL SIZE: **Core estimated to be 22.8 lightyears across**
BEST TIME TO SEE: **Jan 1st 02:00, Feb 1st 00:00, Mar 1st 22:00**

In 2012, two exoplanets were discovered orbiting separate stars in the Beehive cluster. They’re both ‘hot Jupiters’ – gas giants with orbits close to their star

M44

THE BEEHIVE CLUSTER

Get a buzz from viewing this beautiful open cluster found in the centre of Cancer

NAKED EYE The view from the ground

This open cluster, Messier 44, is also known by various names including the Beehive Cluster and Praesepe ('manger'). It looks like a nebulous cloud in the centre of the faint inverted 'Y' of Cancer. Two middle-brightness stars can be seen to the northeast and southeast of the cluster. These are mag. +4.7 Gamma (γ) Cancri, or Asellus Borealis, and mag. +3.9 Delta (δ) Cancri, or Asellus Australis. The names mean northern and southern donkey: the ancient Greeks and Romans saw them as eating from the manger. To locate it, draw an imaginary line between Regulus in Leo and Castor in Gemini. M44 sits 4° (that's eight times the apparent diameter of the full Moon) south of its mid-point.

BINOCULARS Getting a closer look

Binoculars arguably give the best view of the Beehive Cluster, showing a beautiful collection of stars, quite well separated from one another, like a cloud of bees. Although this is clearly the source of the name, some confusion does arise because of a small pattern of seventh magnitude stars which form a shape that looks like a house on its side. With a bit of imagination, this could be seen as the 'beehive'. Perhaps the fact that it has been tipped onto its side is why the bees are so agitated and swarming around it? The Beehive stars share an age, around 600-700 million years, and proper motion with the Hyades open cluster in Taurus. Consequently, it's thought that both clusters may have originated from the same star forming region.

TELESCOPE Seeing all the detail

Being large and spread out, it's best to use a low magnification to get a good view of M44 through a telescope. M44 contains a number of red giants and white dwarfs indicative of an ageing stellar population. The cluster has undergone mass segregation, resulting in the more massive, brighter members being concentrated in the core and the dimmer, less massive ones ejected into a halo, which merges with the general star field. The eclipsing binary star TX Cancri is located half a degree south of the cluster's centre. This is a contact binary, where both stars share their outer layers. From Earth we get to see the effects of a partial eclipse, causing the star to dip in brightness from mag. +10.00 to +10.35 with a periodicity of 9.19 hours.

THINKSTOCK, PETE LAWRENCE X 3

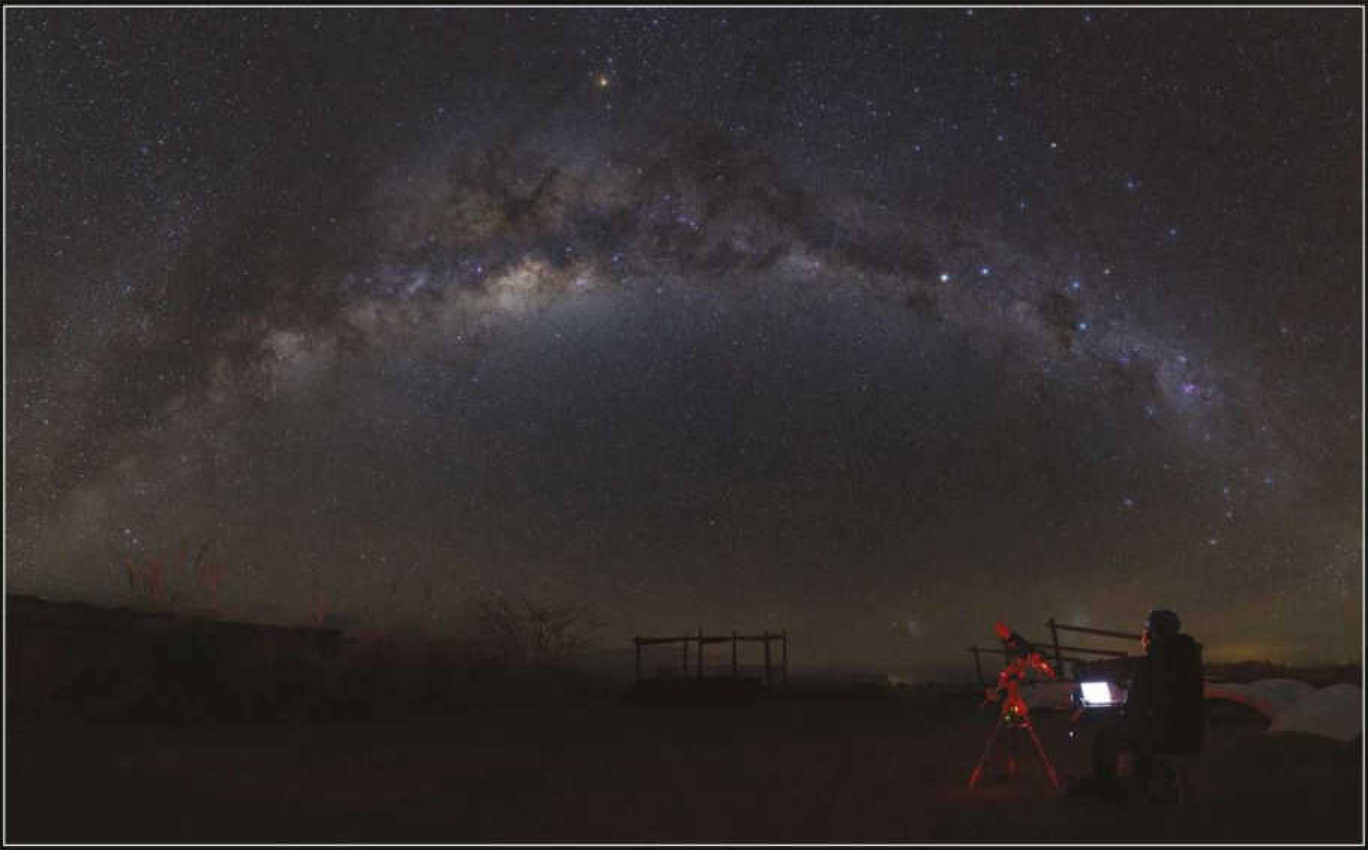
INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

WINNER
OUR MOON

Full Face of our Moon
András Papp, Hungary

▼ RUNNER UP
PEOPLE & SPACE

Eternity and Astrophotographer
Yuri Zvezdny, Russia



April

Look out for close passes between the Moon and planets all month

KEY DATES

6 APRIL
The Moon occults Venus in broad daylight

8 APRIL
Mercury and a 2% waxing crescent Moon are close, low in the west at 21:00 BST (20:00 UT)

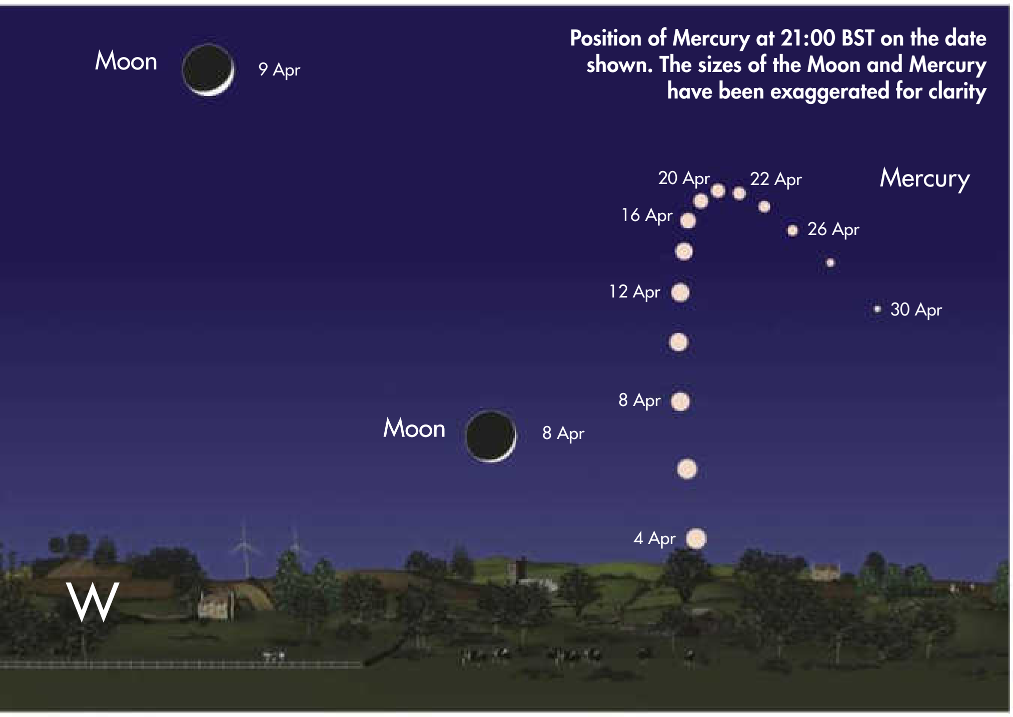
18 APRIL
Mercury reaches greatest eastern elongation (20°) and is well placed in the evening sky

22 APRIL
Peak of the April Lyrid meteor shower. The full Moon will interfere

26 APRIL
Saturn is 3.5° from the 87% waning gibbous Moon at 00:30 BST (23:30 UT on the 25th)

APRIL at a glance

A month of colourful stars that sees great planet views too

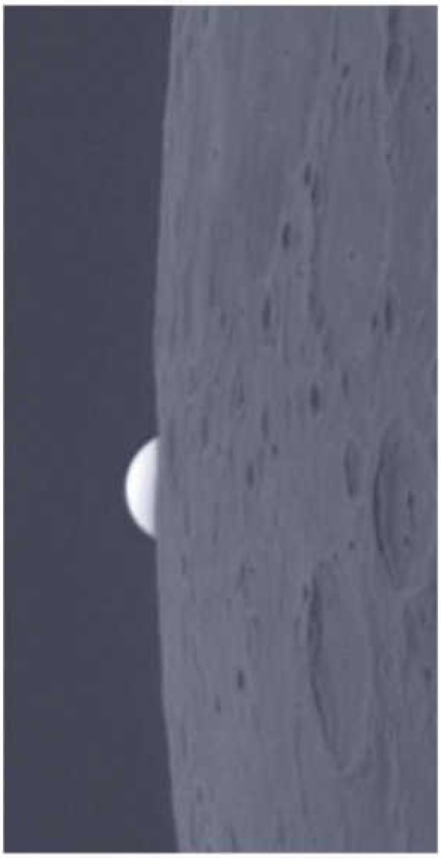

Moon
9 Apr
Position of Mercury at 21:00 BST on the date shown. The sizes of the Moon and Mercury have been exaggerated for clarity
20 Apr
22 Apr
Mercury
16 Apr
26 Apr
12 Apr
30 Apr
8 Apr
Moon
8 Apr
4 Apr
W

As the sky starts to darken, the first bright object to appear is the planet Jupiter, which is currently located among the back legs of Leo. Look east of Jupiter to find orange mag. –0.1 Arcturus (Alpha (α) Boötis) the brightest star in kite-shaped Boötes, the Herdsman.

The kite shape is well defined, but it helps to know that it appears about as high as the Plough is long. Arcturus sits at the pointed end of the kite. Another way to locate the star is to follow the handle of the Plough away from the blade. If you're not sure what an old fashioned plough looks like, then imagine the pattern as a saucepan, extending the natural arc of its handle away from the pan. Eventually, this arc arrives at Arcturus.

Continue the arc to arrive at mag. +1.0 Spica (Alpha (α) Virginis), the brightest star in Virgo. Compare the colours of this pure white star with the orange of Arcturus – the difference is quite striking. Virgo is tricky to describe as it's large and sprawling. Its main feature is a large semi-circular pattern known as the Bowl of Virgo. In between the bowl and the tail of Leo, marked by mag. +2.1 Denebola (Beta (β) Leonis), is a region packed with faint galaxies. If you have a telescope, it's worth putting in a low- to medium-power eyepiece and slowly sweeping this region when the Moon's not around. The many faint smudges seen here are distant galaxies. The region is so rich with them that it's known as the Realm of Galaxies.

PETE LAWRENCE X 3



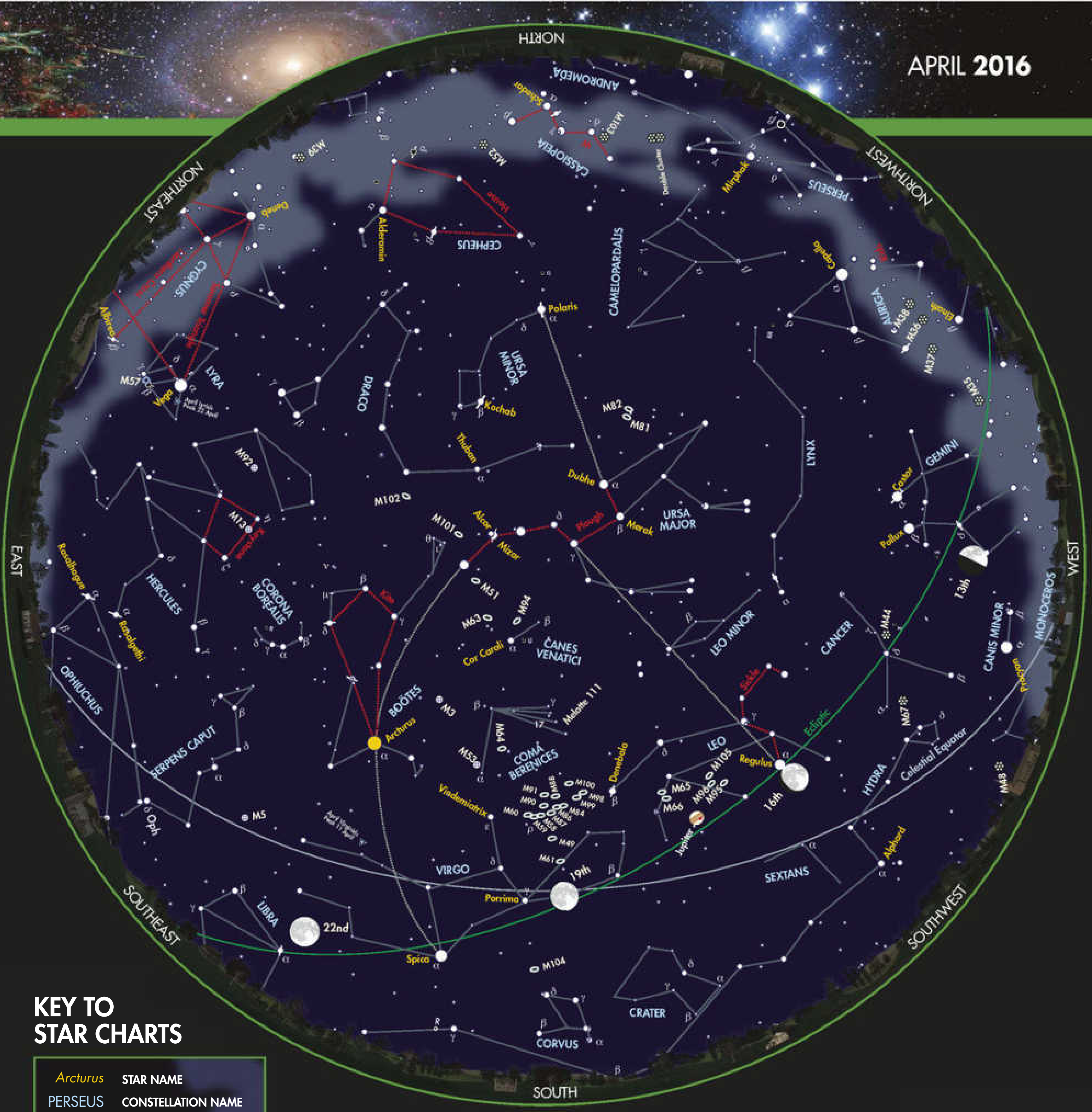
Venus visible past the edge of the Moon during a lunar occultation

Sails and scales

Virgo is highest in the sky in the hours close to midnight. Overhead at this time is the familiar pattern of the Saucepan, mentioned earlier. Imagine the Saucepan's handle as part of a circle, and its centre is marked by the star mag. +2.9 Cor Caroli (Alpha (α) Canum Venaticorum), the brightest star in Canes Venatici, the Hunting Dogs. It's a small constellation with two main stars, Cor Caroli and mag. +4.2 Chara (Beta (β) Canum Venaticorum). Rotate the line between them around Chara, 90° clockwise, and the rotated end points to the variable star Y Canum Venaticorum. Just visible on the edge of vision, this is a lovely star to look at through binoculars or a low-power telescope because of its deep red colour. Its other name is La Superba, and when you see the colour you'll realise why!

The small yet distinctive constellation of Corvus, the Crow, can be seen low down below the bowl of Virgo. Its informal name is the Sail, and with a good imagination you might be able to picture a celestial sailing boat edging along the southern horizon. Further east, and to the southeast of Virgo, lie two mid-brightness stars that form a distinctive 45° line in the sky. These are the main stars of Libra, the Scales, and herald a change in the seasons as they mark the start of summer sky.

Venus is not well placed this month, but can, with care, be picked up in daylight, 17° west-southwest of the Sun. On 6 April at 08:37 BST, the 1% lit waning crescent Moon will move in front of the planet. Reappearance occurs at 08:57 BST. All times are for the centre of the UK and will vary slightly with location. The occultation can be seen from south of a line running along the border of Scotland, through Dundalk to Galway in Ireland. Along this line the Moon's limb will graze in front of Venus's disc.



KEY TO STAR CHARTS

Arcturus	STAR NAME
PERSEUS	CONSTELLATION NAME
⬭	GALAXY
◌ ❄	OPEN CLUSTER
⊕	GLOBULAR CLUSTER
◇	PLANETARY NEBULA
□	DIFFUSE NEBULOSITY
●	DOUBLE STAR
○	VARIABLE STAR
◐	THE MOON (SHOWING PHASE)
☄	COMET TRACK
☄	ASTEROID TRACK
⋯	STAR-HOPPING PATH
△	METEOR RADIANT
Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

●	●	•	·	·
MAG. 0 & BRIGHTER	MAG. +1	MAG. +2	MAG. +3	MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Well placed in the evening sky. A 2% waxing Moon lies 6.5° left of Mercury on the 8th

VENUS
Venus is badly placed, rising with the Sun. The Moon occults it in daylight on 6 April

MARS
Mars is in Ophiuchus, and reverses this month. It travels east before the 17th and west after

JUPITER
Jupiter is well placed among the stars that make up the back legs of Leo

SATURN
Reaches its highest point in the sky, due south, while the sky is dark. It's very low from the UK

URANUS
Not visible this month

NEPTUNE
Not visible this month

MOON PHASES Key stages in the monthly cycle

NEW MOON
7 Apr

FIRST QUARTER MOON
14 Apr

FULL MOON
22 Apr

LAST QUARTER MOON
30 Apr

INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

WINNER
PEOPLE & SPACE

Sunset Peak Star Trail
Chap Him Wong, Hong Kong

▼ RUNNER UP
GALAXIES

The Antennae Galaxies – Extreme Deep Field – 75 Hours
Rolf Olsen, Denmark

May

The 9th's transit of Mercury is the main event this month

KEY DATES

5/6 MAY
The Eta Aquariid meteor shower peaks, coinciding with new Moon

7 MAY
Chance to catch a 1% waxing crescent Moon low in the west-northwest after sunset

9 MAY
The planet Mercury transits the Sun between 12:12 BST and 19:42 BST

22 MAY
A 98% waning gibbous Moon lies 2.5° north of Saturn at 23:00 BST (22:00 UT)

30 MAY
Although Mars is at opposition on 22 May, it's closest to Earth tonight

MAY at a glance

Shorter nights but plenty to see as summer rolls around

May 2016 is a very exciting month because Mars is at opposition on the 22nd and Mercury transits the disc of the Sun on the 9th. Unlike the very rare transit of Venus (the next one won't occur until 2117) transits of Mercury occur at more frequent intervals. The last one visible from the UK was in 2003 and the next after this year will be in 2019. It'll take 7.5 hours for the planet to move across the Sun's disc, so it's not a rushed event!

As we approach the middle of the year nights are becoming very short, and by the end of May they never get 'astronomically' dark at all from the UK. Astronomical darkness occurs when the Sun is more than 18° below the horizon.

The main star on show is mag. –0.1 Arcturus (Alpha (α) Boötis), the orange supergiant that sits at the bottom of the large kite-shaped constellation of Boötes, the Herdsman. The star is a little over halfway up the sky looking south during most of May, and will have drifted off to the west of south by the end of the month. Look to the east of Arcturus by approximately the same distance that Arcturus is above the horizon to see another really bright star: steely blue mag. 0.0 Vega (Alpha (α) Lyrae), the brightest star in Lyra. To confirm you have the right star, look for the squashed diamond of fainter stars to Vega's southeast.

Mars hits opposition on 22 May and is closest on the 30th

Key line

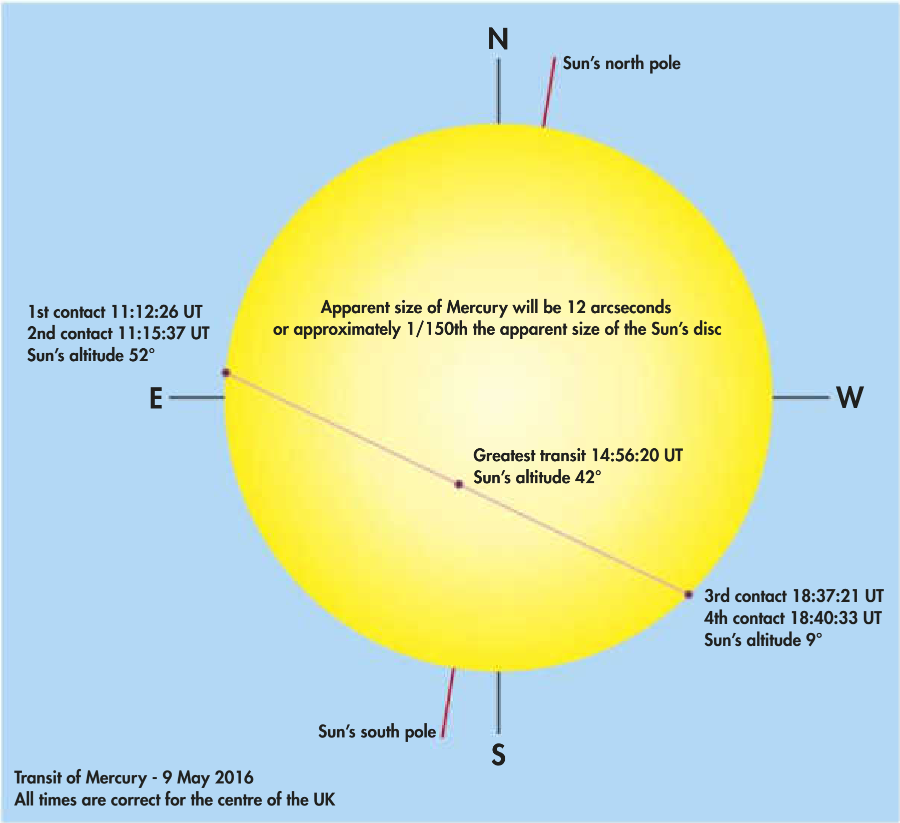
If you imagine a line between Vega and Arcturus, this can be useful for identifying other patterns and constellations. Starting at Vega, one third of the way along the line is a faint pattern of four stars known as the Keystone because of its resemblance to the stone that locks stone arches in place. One third of the way down the western side of the Keystone is an amazing object that can just be glimpsed with the naked eye from a good, dark site. Binoculars show it as a slightly fuzzy star while a telescope reveals it in its true glory. This is M13, the Great Globular Cluster in Hercules, possibly a million stars in a very compact space.

As its name suggests, M13 lies in the constellation of Hercules, the Strongman, and the Keystone represents the bottom of his torso. Despite what his classic stick figure might show, Hercules is actually upside down as seen from the UK. His head, marked by the star Rasalgethi, lies close to the star Rasalhague, representing the head of Ophiuchus, the Serpent Bearer – a large, visually sparse constellation, sometimes described as an inverted flower pot.

Ophiuchus is unusual for two reasons. First, it sits in the middle of the constellation of Serpens, the Snake. As serpent bearer, the snake is depicted either side of Ophiuchus – no other constellation splits in two like this. Second, the Sun's path, marked by the ecliptic, cuts through Ophiuchus, so planets and the Moon will also pass through it. Saturn can currently be seen hanging around Ophiuchus's legs with Mars off to the west, currently in Libra.

Return to the line between Vega and Arcturus, and two-thirds of the way along from Vega lays the beautiful semi-circular constellation of Corona Borealis, the Northern Crown. The brightest star in the pattern is called Gemma, which represents the jewel in the crown.

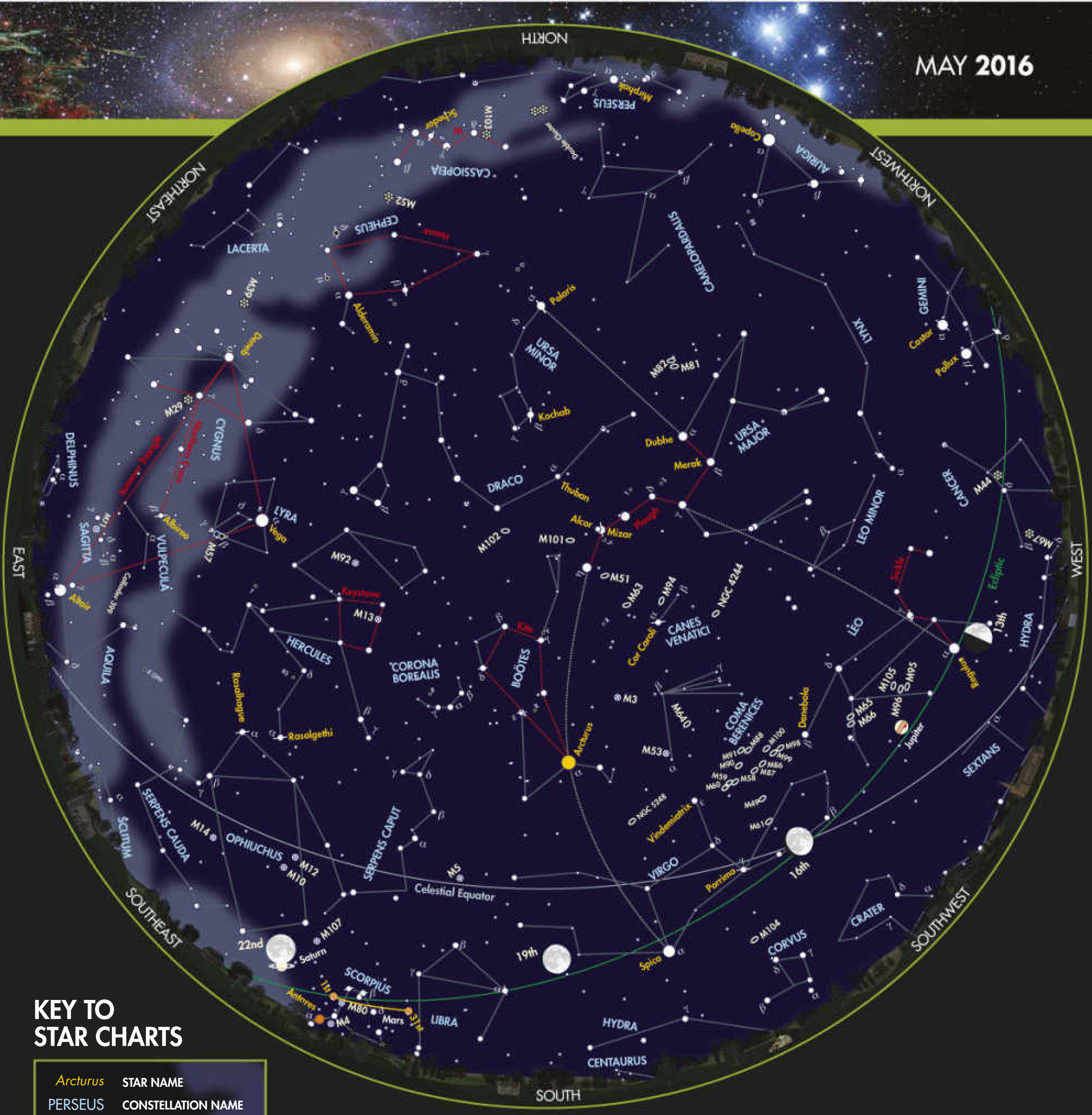
Finally, keep a look out for Eta Aquariid meteors in the early hours around 5-6 May as the shower peaks. The Moon will be new and won't interfere.



Transit of Mercury - 9 May 2016
All times are correct for the centre of the UK

Watch Mercury cross the Sun's disc on 9 May – taking appropriate precautions, of course

PETE LAWRENCE X 3



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Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

●	●	•	·	·
MAG. 0 & BRIGHTER	MAG. +1	MAG. +2	MAG. +3	MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Poorly located all month. The best time to see it is as a silhouette transiting the Sun on 9 May

VENUS
Venus is lost to the Sun's glare in the morning sky during May

MARS
Mars reaches opposition on 22 May, although it'll be very low as seen from the UK

JUPITER
Past its best and rapidly losing ground against the evening twilight as the month progresses

SATURN
Approaching opposition (early in June) so is best around midnight UT

URANUS
Not visible this month

NEPTUNE
Not visible this month

MOON PHASES Key stages in the monthly cycle

NEW MOON
6 May

FIRST QUARTER MOON
13 May

FULL MOON
21 May

LAST QUARTER MOON
29 May

INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

WINNER
AURORAE

Silk Skies
Jamen Percy, Australia

◀ RUNNER UP
OUR MOON

ISS Terminator Moon
Daniel Fernández Caxete, Spain

June

The summer solstice and short nights see Saturn at opposition

KEY DATES

ALL MONTH
Look out for noctilucent clouds which may be visible 90-120 minutes after sunset low in the northwest, or a similar time before sunrise low in the northeast

3 JUNE
Saturn reaches opposition

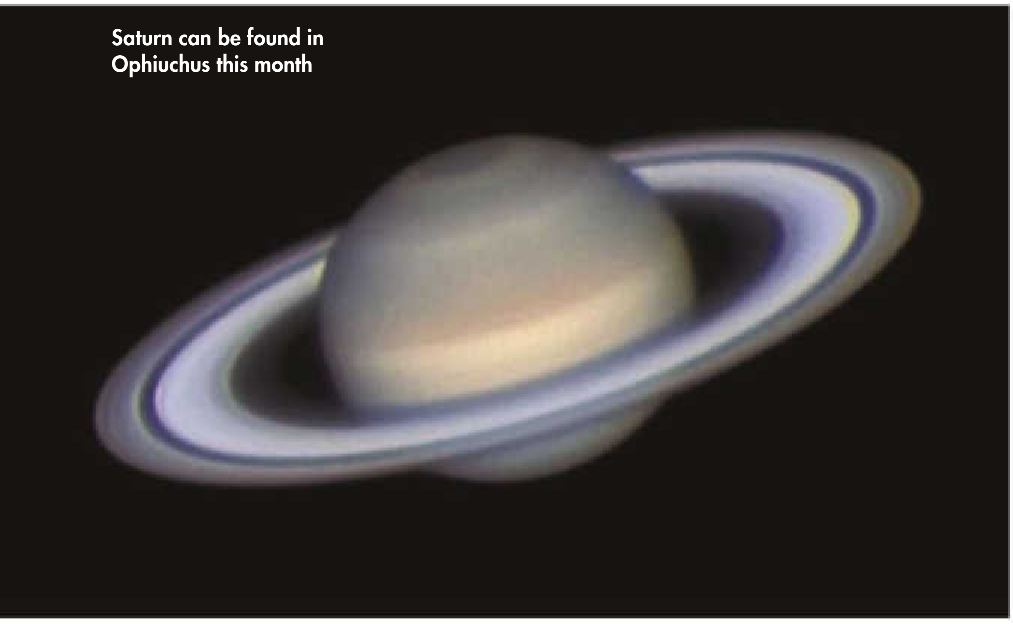
16 JUNE
The June Lyrid meteor shower reaches its peak on 15-16 June

18 JUNE
The 98% lit waning gibbous Moon lies 2.5° north of Saturn at 23:00 BST (22:00 UT)

20 JUNE
The Northern Hemisphere's summer solstice occurs at 22:34 UT

JUNE at a glance

Great stars are visible, but you'll need to be quick



Saturn can be found in Ophiuchus this month

The short nights that occur during June aren't optimal from the UK, but with a bit of persistence there is a lot of amazing stuff to see. The Sun reaches its highest point in the sky on 20 June, marking the Northern Hemisphere's summer solstice. Around this time, night only lasts for a couple of hours at best, and even then the sky never gets truly dark. The counter to this is that the stars visible during June and July are among the best visible all year round – but you don't have very long to admire them!

Centre stage mid-month is the large and ill-defined constellation of Ophiuchus, the Serpent Bearer. The serpent he carries is depicted by the constellation of Serpens. Unusually for a constellation, this one is divided into two parts; Serpens Cauda to the east representing the tail, and Serpens Caput to the west representing the head.

Planetary rivals

Saturn can be seen lurking among the stars that mark the serpent bearer's legs, with Mars off to the west. Look below the ringed planet and you will see a star that looks like a dimmer version of Mars. This is Antares, a name which literally means 'rival of Mars'. Looking at the colour of both planet and star shows just why this is: they are pretty similar. Antares represents the heart of Scorpius. From the UK we never get to see the entire constellation rise properly above the horizon, but the scorpion's body and claws are clearly visible, currently stretching out towards Mars.

The stars to the northwest of Mars, forming what's best described as a 45° line, are the two main stars of Libra, the Scales. These stars are named Zubeneschamali and Zubenelgenubi, which mean 'northern' and 'southern claw'. This comes about because despite its modern separate existence, Libra used to be part of Scorpius. Located to the east of Scorpius is another altitude-challenged constellation, Sagittarius, the Archer. Again, this never completely rises above the UK's southern horizon, but a distinctive part of it can be seen low down which appears like the outline of a teapot and, perhaps unsurprisingly, that's what it's called.

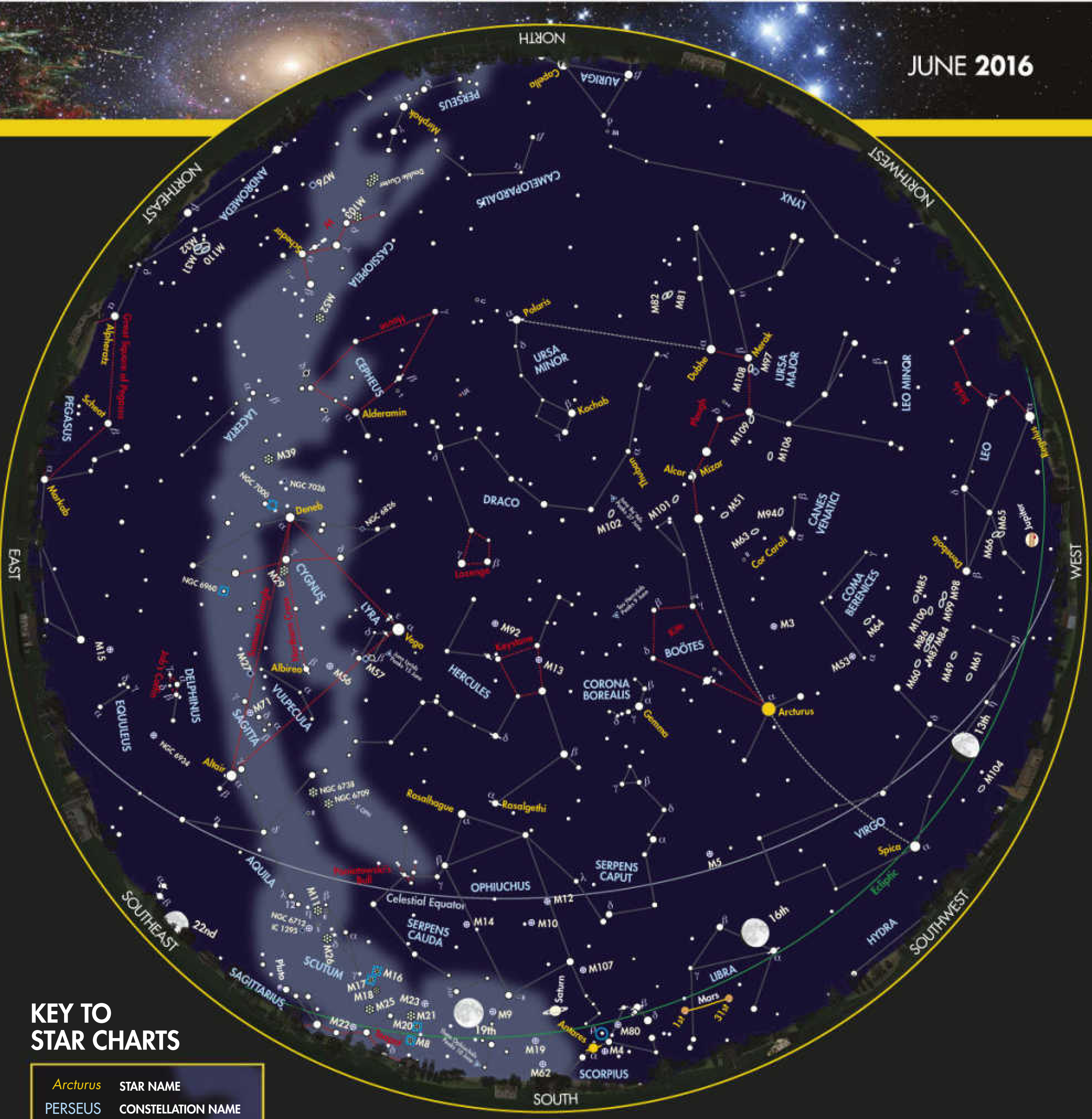
Imagine the spot where steam would be rising from the Teapot's spout, and you'll find a good location to sweep with binoculars or a telescope using a low-power eyepiece. The region is packed with patches of nebulosity and star clusters.

To the north of the Teapot is a pointed-diamond pattern of stars that's tricky to make out and is known as Scutum, the Shield. The top of the shield is pointed at by a faint curve of stars marking the tail of Aquila, the Eagle, the main constellation seen northeast of Scutum. Follow the curved tail round with binoculars or a telescope and you'll find the wonderfully rich Wild Duck Cluster, or M11.

Returning to Aquila, its brightest star is mag +0.8 Altair (Alpha (α) Aquilae), easily recognised by the pair of fainter stars that flank it to the northwest and southeast. Altair forms the bottom point of the Summer Triangle. The other stars can be seen to the north in the form of mag. 0.0 Vega (Alpha (α) Lyrae), which is almost overhead during June, and dimmer mag. +1.3 Deneb (Alpha (α) Cygni) to the east.

Noctilucent clouds on display in 2014

PETE LAWRENCE X 3



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⬭	GALAXY
◌ ❄	OPEN CLUSTER
⊕	GLOBULAR CLUSTER
⌑	PLANETARY NEBULA
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Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

●	●	•	·	·
MAG. 0 & BRIGHTER	MAG. +1	MAG. +2	MAG. +3	MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Reaches greatest western elongation on the 5th but unfavourably positioned

VENUS
Reaches superior conjunction with the Sun on the 6th, and moves from morning to evening sky

MARS
Well positioned on 1 June, Mars loses altitude rapidly by the time darkness falls on 30 June

JUPITER
Jupiter is now losing altitude quickly by the time the sky starts to darken

SATURN
At opposition on the 3rd, visible all night. The full Moon is very close on the night of 18-19 June

URANUS
Not visible this month

NEPTUNE
Not visible this month

MOON PHASES Key stages in the monthly cycle

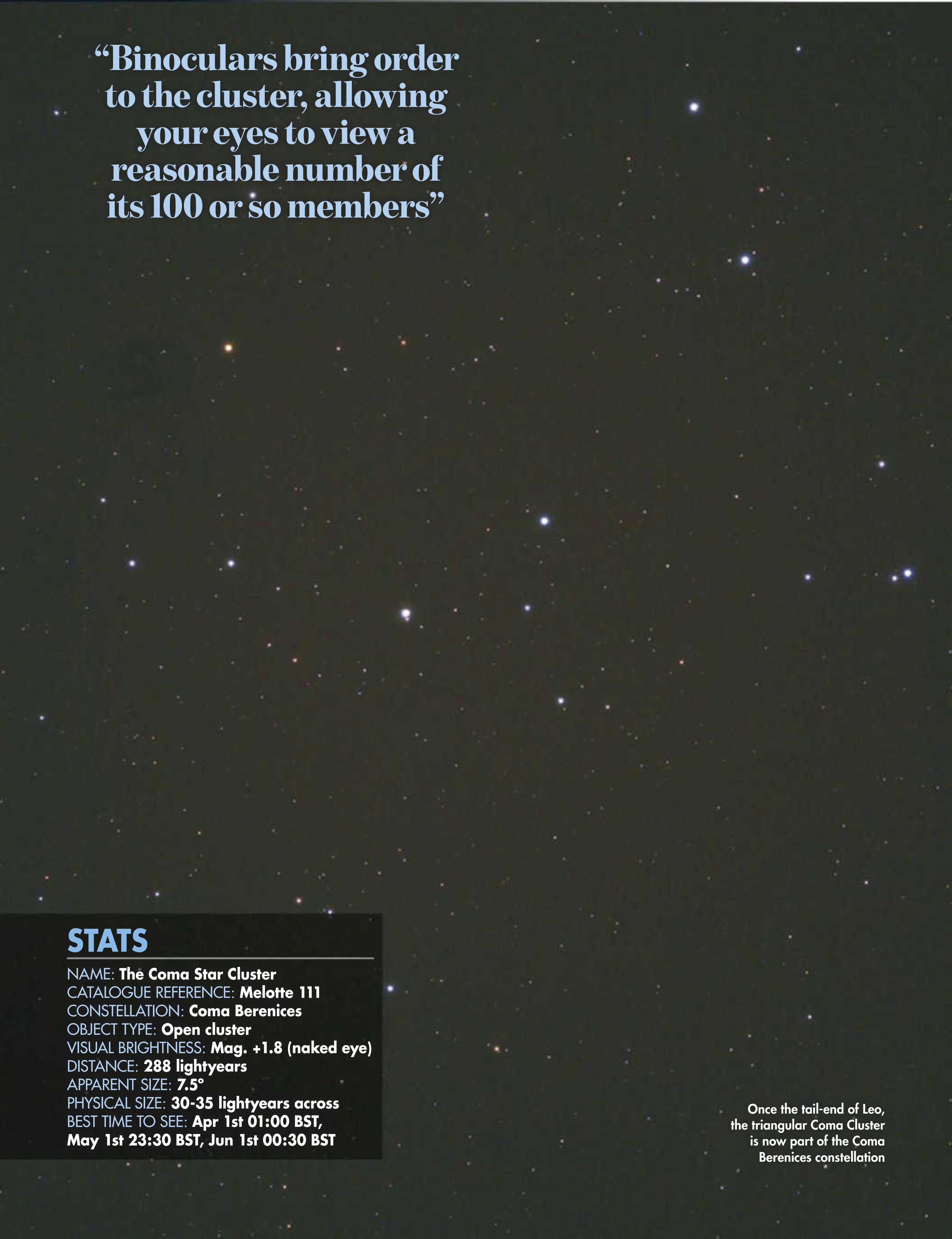
NEW MOON
5 Jun

FIRST QUARTER MOON
12 Jun

FULL MOON
20 Jun

LAST QUARTER MOON
27 Jun

> "Binoculars bring order to the cluster, allowing your eyes to view a reasonable number of its 100 or so members"



Once the tail-end of Leo, the triangular Coma Cluster is now part of the Coma Berenices constellation

STATS

NAME: **The Coma Star Cluster**
CATALOGUE REFERENCE: **Melotte 111**
CONSTELLATION: **Coma Berenices**
OBJECT TYPE: **Open cluster**
VISUAL BRIGHTNESS: **Mag. +1.8 (naked eye)**
DISTANCE: **288 lightyears**
APPARENT SIZE: **7.5°**
PHYSICAL SIZE: **30-35 lightyears across**
BEST TIME TO SEE: **Apr 1st 01:00 BST, May 1st 23:30 BST, Jun 1st 00:30 BST**

MELOTTE 111

THE COMA STAR CLUSTER

A close-by but sparse open cluster which comes into its own on a dark spring night

NAKED EYE The view from the ground

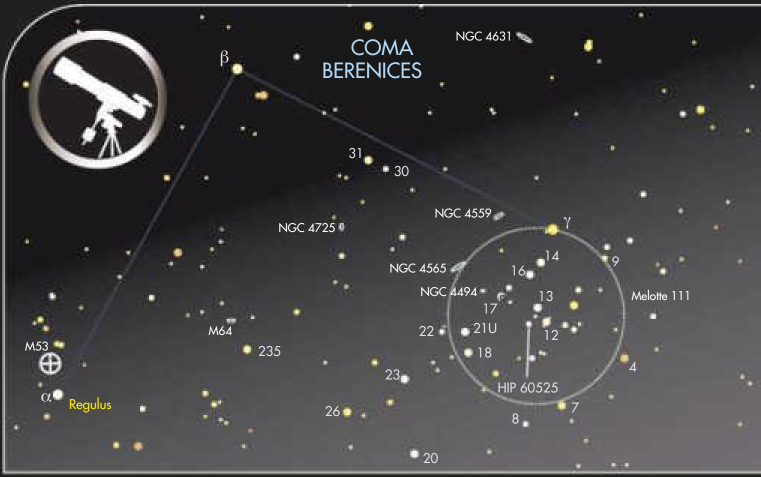
Coma Berenices is a small constellation between Leo and Bootes. In dark skies there's something quite mesmerising about it because Melotte 111, a triangular open cluster spanning 7.5º, forms part of the constellation which represents the hair of Egyptian Queen Berenice II. Legend tells how she bargained with Aphrodite that if her husband, King Ptolemy III, returned from Syria safely she would sacrifice her hair. He did and she kept her bargain, announcing that the goddess had placed her hair among the stars. This came at the expense of the tuft of Leo's tail, which was reassigned to Coma Berenices. The cluster begins at the mag. +4.3 star Gamma (γ) Comae Berenices and then appears to flow and expand as it heads south.

BINOCULARS Getting a closer look

Binoculars bring order to the cluster, allowing your eyes to view a reasonable number of its 100 or so members. A pair of 7x50 binoculars show the whole cluster in one go. Placing Gamma Comae at the top of view, the other stars cascade south. The eastern side is defined by the stars Gamma, 14, 16, 17, 21, 18, 22, 23 and 26 Comae. The western edge of the triangle is less clear. The two mag. +5.0 stars, 13 and 12 Comae, together with mag. +6.4 HIP 60525, form a northwest 'shoulder', but then there's nothing 'structural' until you arrive at mag. +4.9 7 Comae in the southwest. This is a close open cluster to Earth, estimated to be 288 lightyears away and 400 million years old. Its appearance is so sparse that it wasn't recognised as a true cluster until 1938.

TELESCOPE Seeing all the detail

Magnification tends look right through Melotte 111, so a low power eyepiece can look for objects more suitable for higher powers in the cluster's shape. There are many double stars in Coma, some located in the cluster. Mag. +4.8 12 Comae is one, with a 66 arcsecond separation and mag. +5.0/+8.0 components. A third mag. +11.0 component lies 35 arcseconds northeast. 17 Comae is another target with a wide separation of 145 arcseconds and components of mag. +5.5/+6.5. The real show-stopper is 24 Comae, which lies south of Melotte 111. This double has an orange mag. +5.0 primary and blue mag. +6.5 secondary, separated by 20 arcseconds. The more distant but glorious mag. +11 NGC 4565 is an edge-on spiral galaxy.



ROLF LÖHR/CCDGUIDE.COM, PETE LAWRENCE X 3

INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

WINNER
PLANETS, COMETS & ASTEROIDS

The Arrow Missed the Heart
Lefteris Velissaratos, Greece

July

Venus and Mercury get close on the warm summer nights

KEY DATES

ALL MONTH
Noctilucent cloud season continues throughout July

4 JULY
Earth is furthest from the Sun for the year – a point in its orbit known as aphelion

8 & 9 JULY
The waxing crescent Moon is 6° west of Jupiter on the 8th and 6° east on the 9th

16 JULY
Mercury is north of Venus in the evening sky

19 JULY
The low full Moon is a great opportunity to see the Moon illusion that makes it look artificially large

RUNNER UP ▶
SKYSCAPES SPONSORED BY INSIGHT INVESTMENT

Sunderland Noctilucent Cloud Display
Matt Robinson, UK

JULY at a glance

Watch for noctilucent clouds as the Milky Way passes overhead

The middle months of the year are tricky for astronomy as the sky never really gets dark. The Sun, being at its most northerly position in the sky, just never gets low enough below the northern horizon at night to allow the sky to become astronomically dark – when the Sun is more than 18º below the horizon.

All is not lost, however, and there are some amazing things to look out for. The Northern Hemisphere's noctilucent cloud (NLC) season continues through July. These amazing high altitude clouds may be seen typically 90-120 minutes after sunset low in the northwest or a similar time, low in the northeast, before sunrise. A big display may be visible all night long gradually moving from the northwest, through north and into the northeast as the Sun tracks below the horizon.

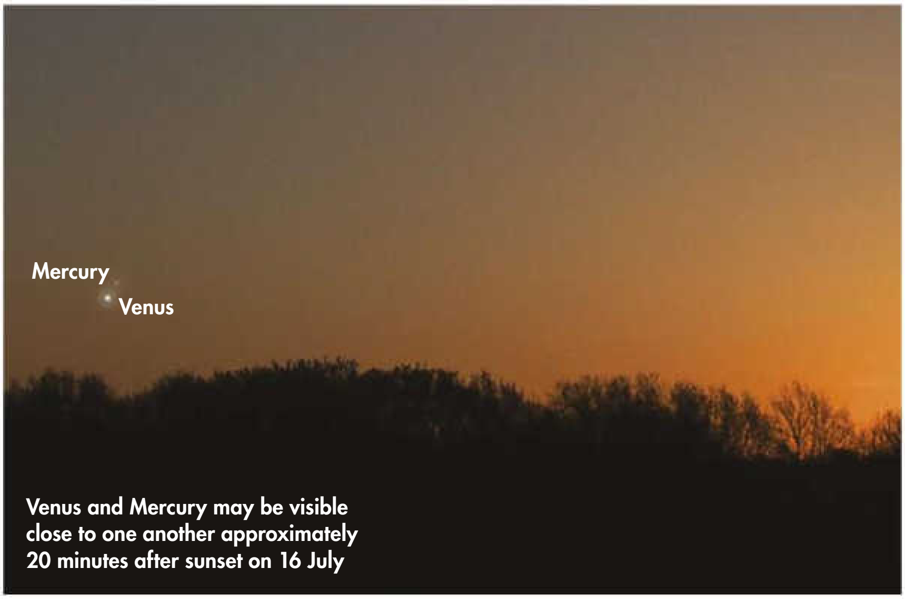
They're created by atmospheric particles, believed to be the fragments left behind after meteor vaporisation, around which tiny ice crystals form. They're the highest type of cloud, 76-85km up and high enough to catch the Sun's light when we're in darkness on the ground. So, if present, NLCs appear to shine at night. There's no guarantee they will be visible but the brightest displays are so dramatic they sometimes get misreported for the aurora.

The double star Albireo is quite beautiful if you can split the pair

July is arguably the best time to catch a glimpse of the spectacular summer Milky Way. From a dim start in the north, it starts to get quite bright as it heads south and is easily seen if you have good dark skies. The portion close to the southern horizon passes through Sagittarius. In this direction, you're looking into the core of our Galaxy and the multitude of stars here should make it look really bright, but the core's low altitude dims its intensity.

Cygnus Rift

Look high up through the cross-shaped constellation of Cygnus, the Swan and you'll see the best section of the Milky Way visible from the UK. As it passes down the asterism known as the Northern Cross, it appears to split in two. This is caused by intervening galactic dust getting in the way of the light from the more distant stars. This particular 'split' is known as the Cygnus Rift. The star at the foot of the Northern Cross is a highly recommended telescope target. This is mag. +3.0 Albireo (Beta (β) Cygni), one of the best double stars in the night sky, showing a bright yellow primary and azure blue secondary.

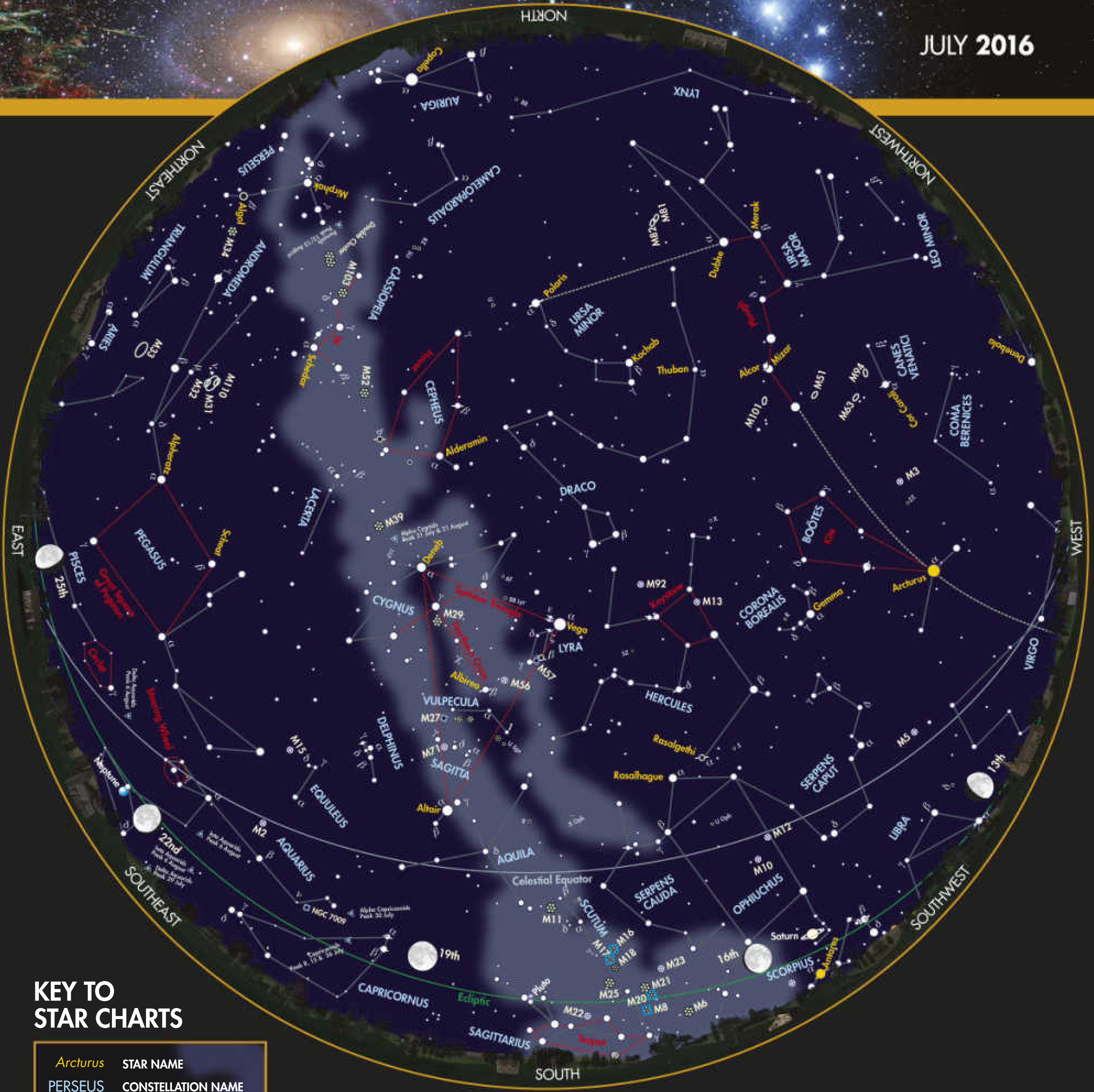


Venus and Mercury may be visible close to one another approximately 20 minutes after sunset on 16 July

PETE LAWRENCE X 3

The Milky Way flows down through Cygnus and through the giant Summer Triangle asterism formed from the three bright stars mag. +1.3 Deneb (Alpha (α) Cygni), mag. 0.0 Vega (Alpha (α) Lyrae) and mag +0.8 Altair (Alpha (α) Aquilae). Inside the triangle it encounters two faint constellations near the base of the Northern Cross; Vulpecula, the Fox and Sagitta, the Arrow. Tiny Sagitta is probably the easiest of the pair to pick out, with the virtue that it does actually look like a small arrow. To its east is the distinctive pattern of Delphinus, the Dolphin. It's sometimes mistaken for the beautiful Pleiades open cluster, which will become visible in the autumn and winter months.

The Milky Way flows out through the bottom of the Summer Triangle, through Aquila, the Eagle and into Scutum, the Shield. Here it glows quite brightly due to the presence of the Scutum Star Cloud. This compact, heart-shaped region of the Milky Way is bright enough to trick the unwary into thinking terrestrial clouds are coming in to spoil the view.



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STAR BRIGHTNESS:

●	●	•	•	·
MAG. 0 & BRIGHTER	MAG. +1	MAG. +2	MAG. +3	MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
At conjunction on the 7th, moving into the evening sky for close encounter with Venus on the 16th

VENUS
Venus is slowly moving away from the Sun. However, its low post-sunset altitude makes it tricky to see

MARS
Shrinking through a telescope. At the end of July, it's 11° west of Antares

JUPITER
Now past its best and found low in the west as darkness falls

SATURN
Low in the south as darkness falls. Close to Mars at present

URANUS
Currently in Pisces, 2.7° north of mag. +4.8 Mu (μ) Piscium

NEPTUNE
In Aquarius, 0.5° south of Lambda (λ) Aquarii. Culminates in darkness this month

MOON PHASES Key stages in the monthly cycle

NEW MOON
4 Jul

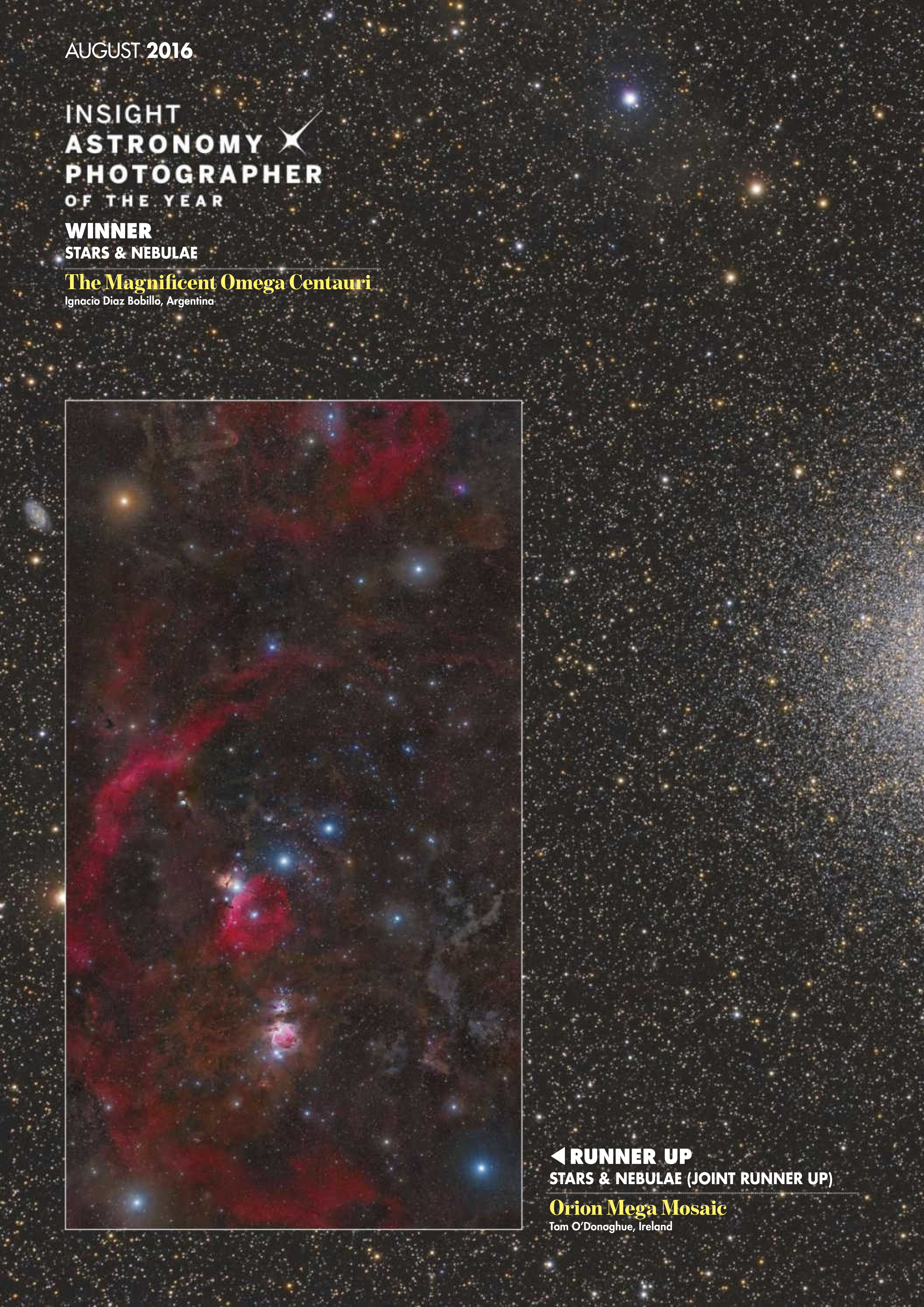
FIRST QUARTER MOON
12 Jul

FULL MOON
19 Jul

LAST QUARTER MOON
26 Jul

AUGUST 2016

INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR



WINNER

STARS & NEBULAE

The Magnificent Omega Centauri

Ignacio Diaz Bobillo, Argentina

◀ **RUNNER UP**

STARS & NEBULAE (JOINT RUNNER UP)

Orion Mega Mosaic

Tom O'Donoghue, Ireland

August

Darker skies see meteors and close planetary passes

KEY DATES

4 AUGUST
Mercury is 1.75° northeast of a 4% waxing Moon, visible 20 minutes after sunset

11 AUGUST
A 60% waxing gibbous Moon, Mars and Saturn form an equilateral triangle as darkness falls

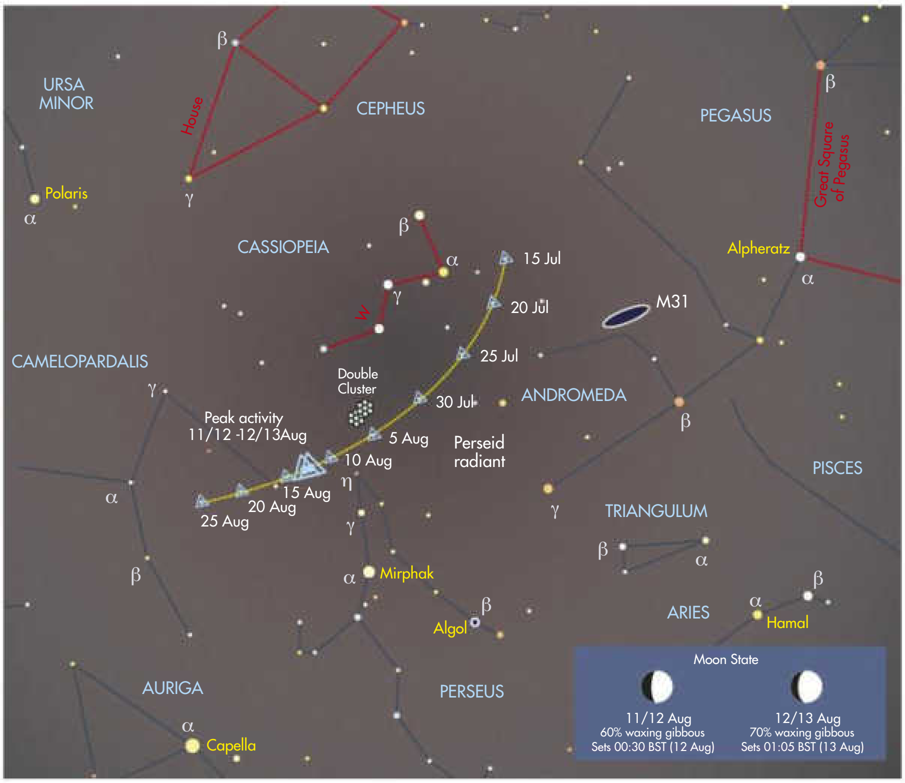
12 AUGUST
Perseid meteor shower peaks. A 69% waxing gibbous Moon, Mars and Saturn sit in a line as darkness falls

27 AUGUST
Venus and Jupiter are separated by eight arcminutes, visible 20 minutes after sunset, low in the west

31 AUGUST
Chance to see a 1% lit Moon, 45 minutes before sunrise, low in the east

AUGUST at a glance

Clear skies could reveal spectacular meteors



The Perseid meteor shower peaks around the 12th and could be especially active this year

August is an exciting month. The Perseid meteor shower reaches its peak on 12 August. Its high zenithal hourly rate of 80-100 meteors per hour, combined with comfortable viewing conditions, makes it a popular choice for meteor watchers. The medium speed of the trails produced and possibility of bright meteors make it a prime target for photographers too. This year there is a prediction for enhanced Perseid activity, with the potential for up to 150 meteors per hour.

As Sagittarius slips further to the west, it's replaced by some indistinct patterns. The misshapen triangular form of Capricornus, the Sea Goat lies to the east of Sagittarius. The triangle is reasonably easy to pick out, and distinctive because the stars marking the northeast and northwest points of the triangle are pairs.

Aquarius, the Water Bearer is a large arrangement of stars to the north, northeast and east of Capricornus. The shapes here aren't obvious at all apart from a little pattern known classically as the Water Jar asterism. A more modern take on this is that it looks like the central spokes of a three-spoke steering wheel. Inevitably, the Steering Wheel name has stuck and fits the pattern well.

Horses and royalty

Aquarius borders Pegasus, the Flying Horse, one of the key constellations in the autumn sky. The central pattern in Pegasus is a large area called the Great Square of Pegasus. Ironically, one of the four stars in the Great Square belongs to the neighbouring constellation of Andromeda. This is the star in the northeast corner, mag. +2.1 Alpheratz (Alpha (α) Andromedae), from where a wedge of stars emanates.

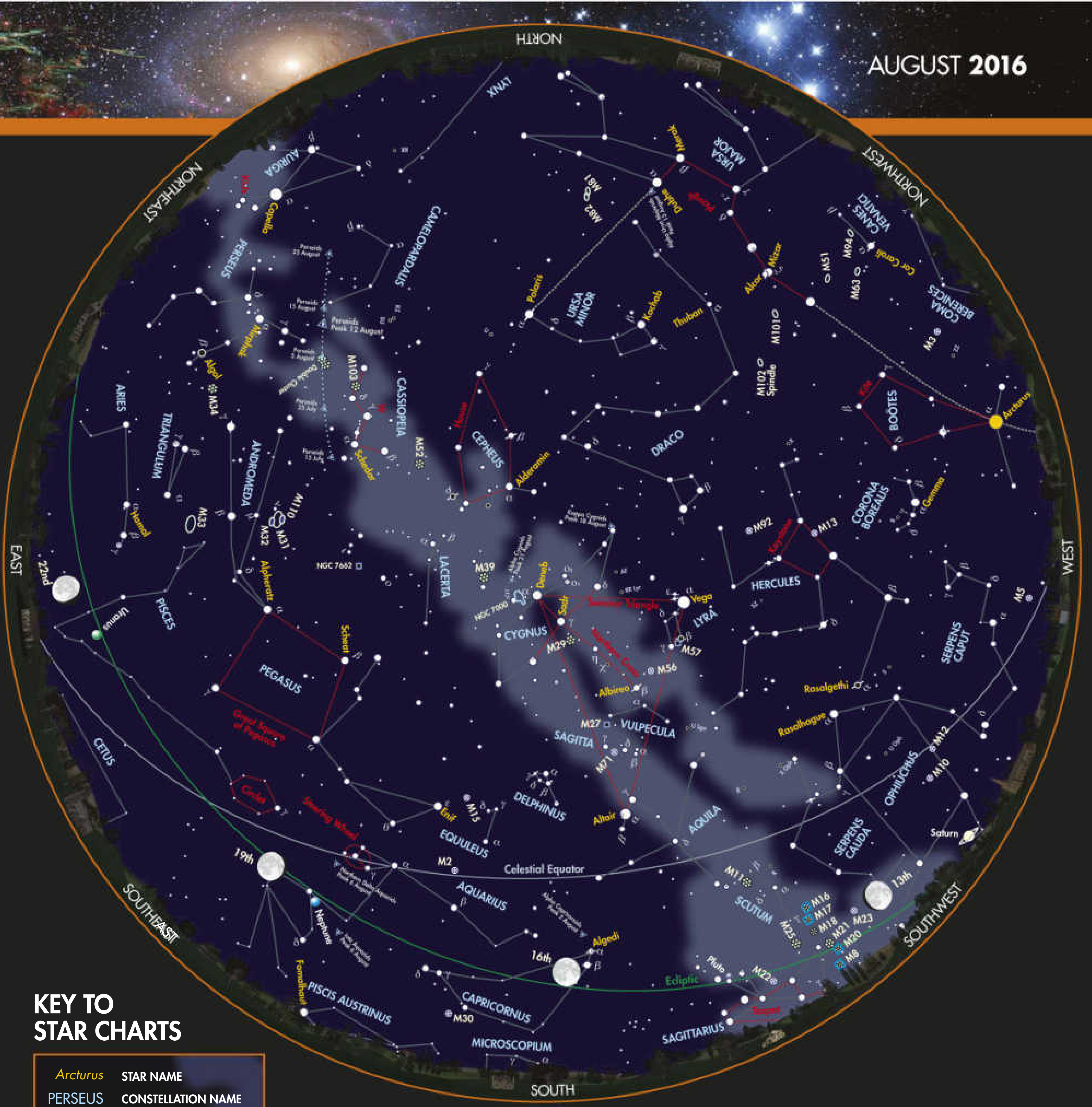
Head north from Capricornus and you'll find the compact diamond form of Delphinus. Southeast of Delphinus sits the small and dim constellation of Equuleus, the Little Horse, which also borders on Pegasus but appears totally overwhelmed by the huge and distinctive Flying Horse.

The familiar cross-shaped constellation of Cygnus lies northwest of Pegasus, highlighted under dark skies by the magnificent Milky Way that runs through it. North of mag. +1.3 Deneb (Alpha (α) Cygni), the brightest star in Cygnus, is the house-shaped constellation of Cepheus, the King. Close by is his queen, the familiar W of Cassiopeia. South of Cepheus there's a faint zig-zag of stars depicting Lacerta, the Lizard. Look hard, and you'll find a miniature W-shape.

Andromeda is the daughter of Cepheus and Cassiopeia in mythology. The queen's boasting about her daughter's beauty upset the gods and they decreed Andromeda be chained to a rock and left to the mercy of a sea monster. She was rescued by Perseus, whose π shape can be found to the east of Andromeda and southeast of Cassiopeia. His presence brings us full circle, because this is where the Perseid meteors appear to emanate from when at their peak.

Venus and Jupiter, visible low in the west, approximately 20 minutes after sunset

PETE LAWRENCE X 3



KEY TO STAR CHARTS

Arcturus	STAR NAME
PERSEUS	CONSTELLATION NAME
⬭	GALAXY
◌ ❋	OPEN CLUSTER
⊕	GLOBULAR CLUSTER
⌑	PLANETARY NEBULA
□	DIFFUSE NEBULOSITY
●	DOUBLE STAR
○	VARIABLE STAR
◐	THE MOON (SHOWING PHASE)
☄	COMET TRACK
☄	ASTEROID TRACK
⋯	STAR-HOPPING PATH
△	METEOR RADIANT
Circlet	ASTERISM
←	MILKY WAY
●	PLANET

STAR BRIGHTNESS:

MAG. 0 & BRIGHTER, MAG. +1, MAG. +2, MAG. +3, MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
At greatest eastern elongation on evening of 16 August. Lost from view after the 17th

VENUS
Pulls away from the Sun but low in the west after sunset. A very close encounter with Jupiter on the 27th

MARS
Less than 2° north of Antares on the 23rd, with Saturn, Mars and the star forming a line

JUPITER
Too close to the Sun for serious observation. It has a close encounter with Venus on 27th

SATURN
On view all month but from the UK is very low

URANUS
Makes it to its highest point in the sky, due south, in darkness at the end of August

NEPTUNE
Approaching opposition and well presented 40 arcminutes south of Lambda Aquarii

MOON PHASES Key stages in the monthly cycle

NEW MOON
2 Aug

FIRST QUARTER MOON
10 Aug

FULL MOON
18 Aug

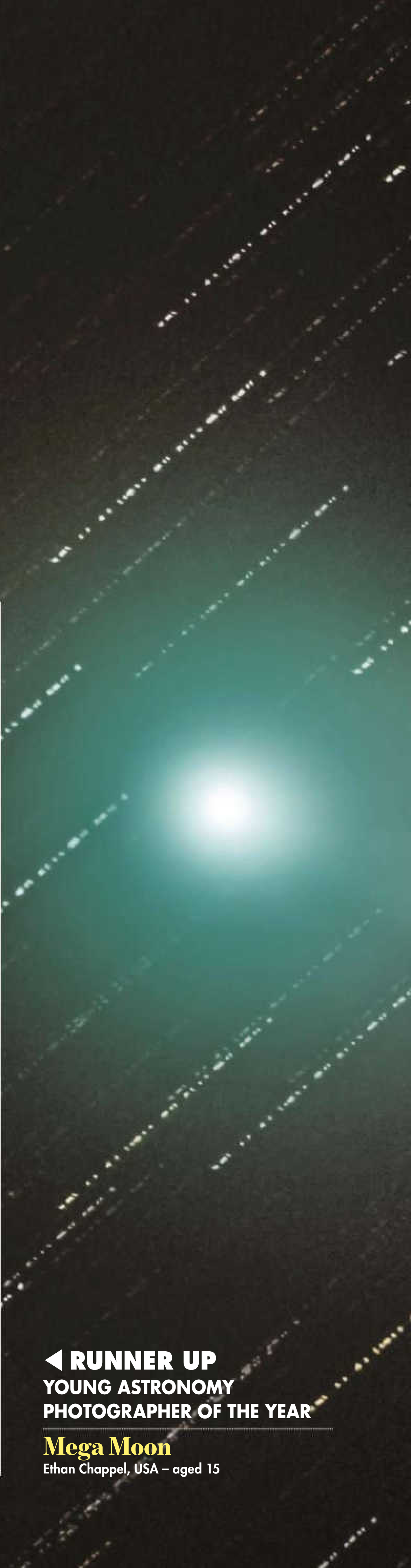
LAST QUARTER MOON
25 Aug

INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

WINNER
YOUNG ASTRONOMY PHOTOGRAPHER OF THE YEAR

A Celestial Visitor

George Martin, UK – aged 15



◀ **RUNNER UP**
YOUNG ASTRONOMY PHOTOGRAPHER OF THE YEAR

Mega Moon

Ethan Chappel, USA – aged 15

September

The nights cool
and lengthen, and
there's lots to see

KEY DATES

1 SEPTEMBER
Saturn, Mars and Antares form an isosceles triangle, low in the south-southwest from 20:00 BST

3 SEPTEMBER
Venus is 15 arcminutes from the Moon's southern limb, visible during the day

15 SEPTEMBER
Neptune reappears from behind the Moon's disc at 20:55 BST

16 SEPTEMBER
A tricky to see penumbral eclipse of the Harvest Moon occurs between 17:52 BST and 21:55 BST

26 SEPTEMBER
The 21% waning crescent Moon lies 5° south of the Beehive Cluster, visible at 05:00 BST (04:00 UT)

SEPTEMBER at a glance

The ideal time to observe the Andromeda Galaxy

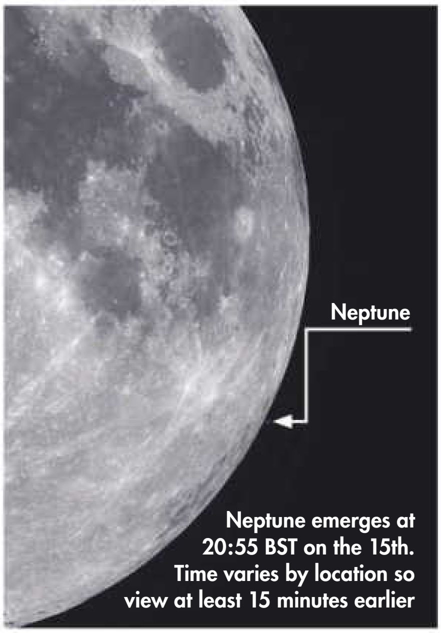
With the Northern Hemisphere's autumn equinox occurring on September 22 at 15:21 BST, the nights really start to draw in this month, bringing a more relaxed opportunity to enjoy the sights on view. Damp autumnal air can cut a telescope viewing session short, but there are a couple of solutions: band heaters for optics, or a 12V camping hairdryer to gently remove any moisture that appears.

With clear optics, one object begging for a closer look is the Andromeda Galaxy, M31. As the sky darkens, the Great Square of Pegasus is visible roughly half-way up the sky in the southeast. The square appears more like a diamond in this location. This pattern is a gateway to locating M31.

Locate the star in the square's southwest corner and imagine the line of the diagonal from here. The star the line eventually meets is mag. +2.1 Alpheratz (Alpha (α) Andromedae), technically an interloper belonging to Andromeda rather than Pegasus. Extend the diagonal for approximately three quarters the distance again, bending slightly south until you reach mag. +2.0 Mirach (Beta (β) Andromedae), which has a similar brightness to the square's other stars.

Change direction by 90º, moving up the sky to reach mag. +3.8 Mu (μ) Andromedae. Keep going to arrive at the fainter mag. +4.5 Nu (ν) Andromedae, and M31 is a short distance to the northwest of here. To the naked eye it looks like an elongated smudge, full of anticipation because it's relatively bright for a galaxy, especially one that's 2.5 million lightyears away! Binoculars show it as a brighter elongated smudge, as does a telescope.

Give yourself time and structure can be seen, such as the dark dust lane that runs along the northwest edge of the main smudge. Two satellite galaxies, M32 and M110, can also been seen with a telescope using a low power eyepiece.



Neptune emerges at 20:55 BST on the 15th. Time varies by location so view at least 15 minutes earlier

Circle, square, triangle

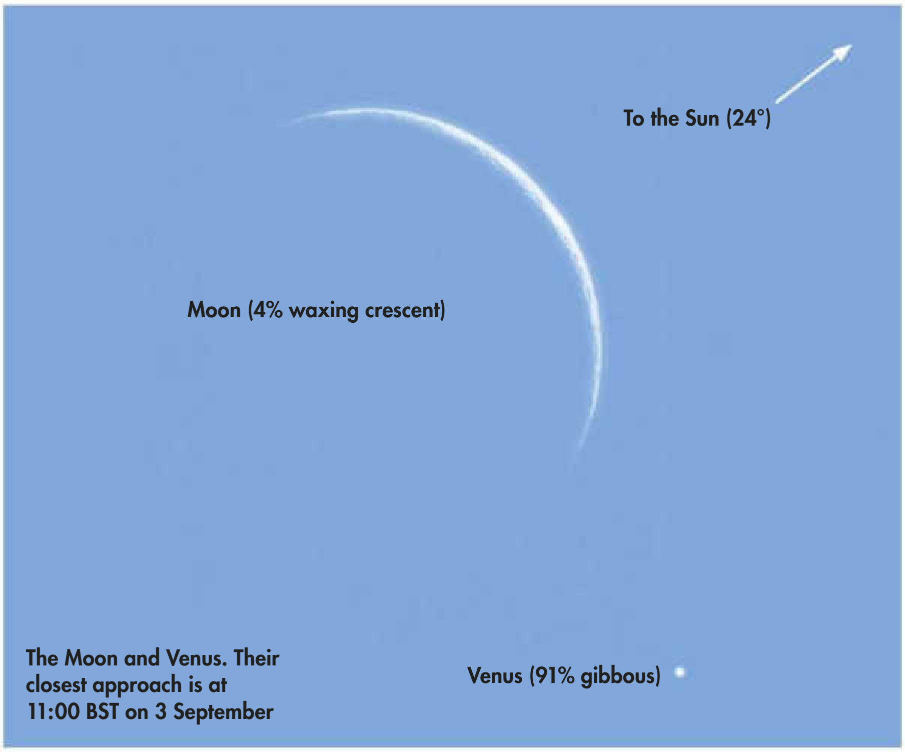
Below the Great Square is another asterism known as the Circlet, a ring of faint stars representing the western fish of Pisces. The rest of the constellation mainly depicts the rope that, in mythology, ties the two fish together. It's represented by a faint line of stars south of the Great Square, running close to its eastern edge. The rope knots at the star mag. +3.8 Alrescha (Alpha (α) Piscium), southeast of the square.

Below Andromeda is a small isosceles triangle of stars known as Triangulum. South of Triangulum lies Aries, the most distinctive part of which looks like a bent line of three stars.

As the Great Square approaches its highest point in the sky, due south, follow the line of the western edge down towards the horizon. This points to the bright star mag. +1.2 Fomalhaut (Alpha (α) Piscis Austrini), in Pisces Austrinus, the Southern Fish. Being so low in the sky from the UK it's easy to miss, so make sure you have a good clear view to the south.

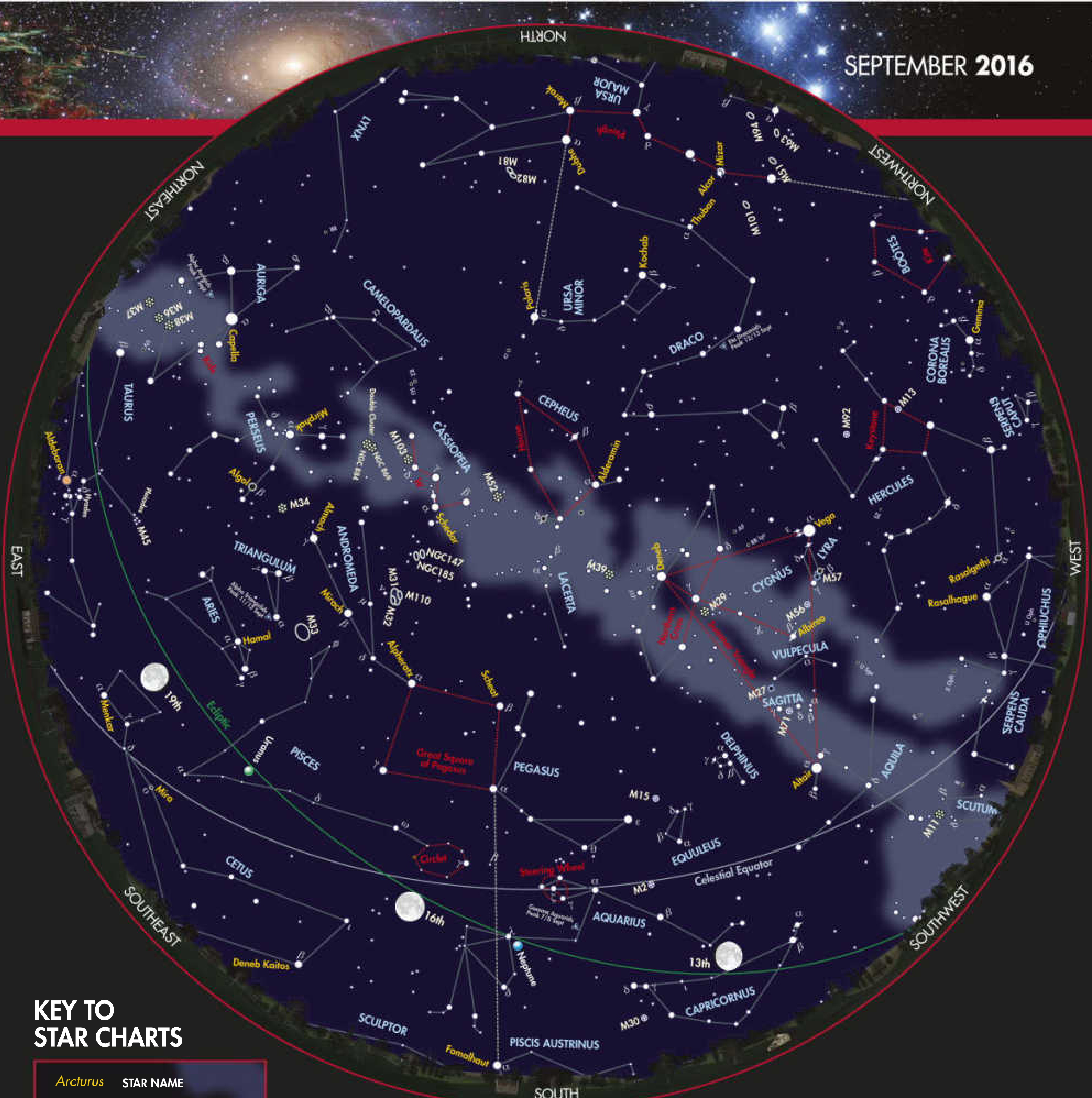
Follow the line of the eastern side of the Great Square south and it will eventually bring you to another obvious star, mag. +2.0 Deneb Kaitos (Beta (β) Ceti). This is part of Cetus, the Whale or Sea Monster, a large constellation that lies southeast of Pisces. The head of the whale is marked by a distorted pentagon of stars below Aries, the brightest member of which is the orange-hued mag. +2.5 Menkar (Alpha (α) Ceti), a name which means 'nostril'.

Finally, visible to the east of Aries is the lovely open cluster known as the Pleiades, or more informally the Seven Sisters. This is a sure sign that autumn is really taking hold.



The Moon and Venus. Their closest approach is at 11:00 BST on 3 September

PETE LAWRENCE X 3



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Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

● MAG. 0 & BRIGHTER · MAG. +1 · MAG. +2 · MAG. +3 · MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Best seen in the morning sky at the end of the month. A 2% lit waning crescent Moon is close on the 29th

VENUS
Evening object, not well placed. A 5% waxing crescent Moon is 3° away on 3 September

MARS
Appears to maintain the same position relative to the horizon, low in the southwest at nightfall

JUPITER
Not visible this month

SATURN
Low as night falls. Makes an equilateral triangle with Antares and Mars on September 1

URANUS
Well placed in the constellation of Pisces, 2.5° north of the mag. +4.8 star Mu (μ) Piscium

NEPTUNE
At opposition on 2 September and visible all night long

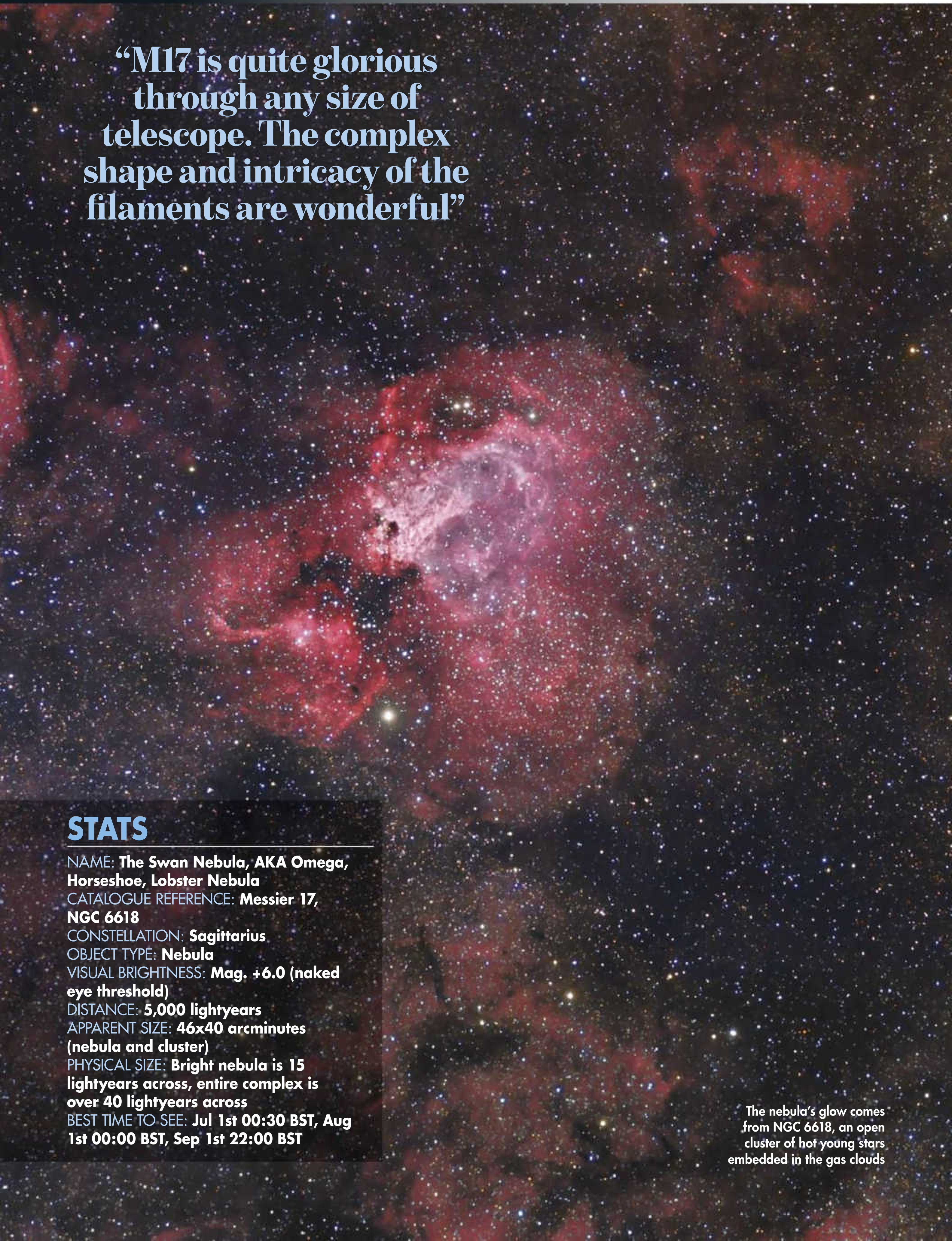
MOON PHASES Key stages in the monthly cycle

NEW MOON
1 Sep

FIRST QUARTER MOON
9 Sep

FULL MOON
16 Sep

LAST QUARTER MOON
23 Sep



> “M17 is quite glorious through any size of telescope. The complex shape and intricacy of the filaments are wonderful”

STATS

NAME: **The Swan Nebula, AKA Omega, Horseshoe, Lobster Nebula**

CATALOGUE REFERENCE: **Messier 17, NGC 6618**

CONSTELLATION: **Sagittarius**

OBJECT TYPE: **Nebula**

VISUAL BRIGHTNESS: **Mag. +6.0 (naked eye threshold)**

DISTANCE: **5,000 lightyears**

APPARENT SIZE: **46x40 arcminutes (nebula and cluster)**

PHYSICAL SIZE: **Bright nebula is 15 lightyears across, entire complex is over 40 lightyears across**

BEST TIME TO SEE: **Jul 1st 00:30 BST, Aug 1st 00:00 BST, Sep 1st 22:00 BST**

The nebula’s glow comes from NGC 6618, an open cluster of hot young stars embedded in the gas clouds

MESSIER 17

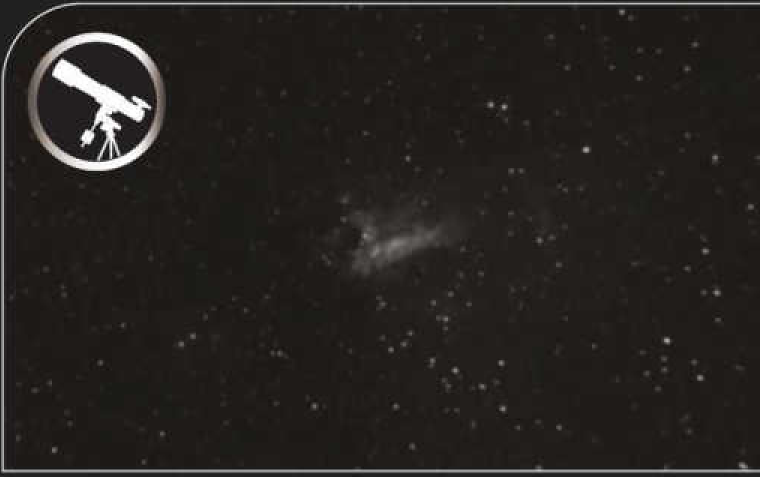
THE SWAN NEBULA

Tricky to see but worth the effort, this nebula has gone by many different names

BINOCULARS Getting a closer look

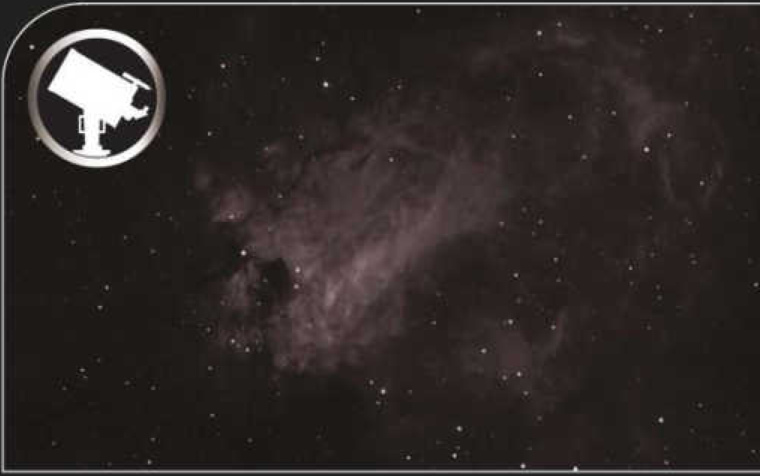
The region to the north of the Teapot asterism in Sagittarius is both tantalising and frustrating from the UK. Even with the naked eye, it's clear to see that there's a lot of 'stuff' in this area, but from the UK this region is low down and only really visible in the months when darkness is at a premium. Located approximately one-third of the way between Gamma (γ) Scuti and Mu (μ) Sagittarii, M17 sits just on the edge of naked eye visibility. With binoculars there's obviously something interesting here. The nebula looks like an elongated bar with 10x50 binoculars, the direction of the bar roughly perpendicular to the line joining a mag. +5.4 star to the northwest of the nebula to the fainter pair nearby.

SMALL TELESCOPE Get more detail



A small telescope can improve the view dramatically as long as you have a good low southern horizon. M17 is quite glorious through any size of telescope. The complex shape of the nebula and the intricacy of the filaments of glowing gas that fill the area are wonderful to follow through the eyepiece. The nebula has an associated open cluster of 40 or so stars and this is the first part of the complex that becomes obvious through a small telescope. With a 150mm scope the gas cloud shows a characteristic elongated shape, but may be tricky to see if the sky isn't properly dark, often the case during the middle months of the year. An OIII filter can help here, and don't be afraid to pile on the power. Magnifications between 50x and 150x should give a good view.

LARGE TELESCOPE See it all



Large telescopes give the best view of M17, but its low UK altitude can make getting one into position difficult. It's certainly worth the effort. The first thing you notice is the tick-like shape of the glowing gas cloud, sometimes described as an elongated '2'. The main 'bar' of nebulosity appears around 12 arcminutes long, widening slightly to the west where a curved extension hangs south of the bar. Seen inverted, this looks a bit like a swan, with a blob of nebulosity above its head. The use of an OIII filter may reveal some delicate, glowing extensions to the east and north of the main bar. With so much to excite the eye, it's no wonder M17 has had so many names, including the Swan, Omega, Horseshoe, Lobster and Checkmark Nebula.

ISTOCK, PETE LAWRENCE X 3

INSIGHT ASTRONOMY PHOTOGRAPHER OF THE YEAR

WINNER

SIR PATRICK MOORE PRIZE FOR BEST NEWCOMER

Orion DT

David Tolliday, UK

October

Autumn constellations take centre stage and the Orionids put on a show

KEY DATES

11 OCTOBER
Mercury and Jupiter are less than a degree apart at 06:45 BST (05:45 UT), low in the east

19 OCTOBER
The waning gibbous Moon moves in front of some Hyades stars early this morning

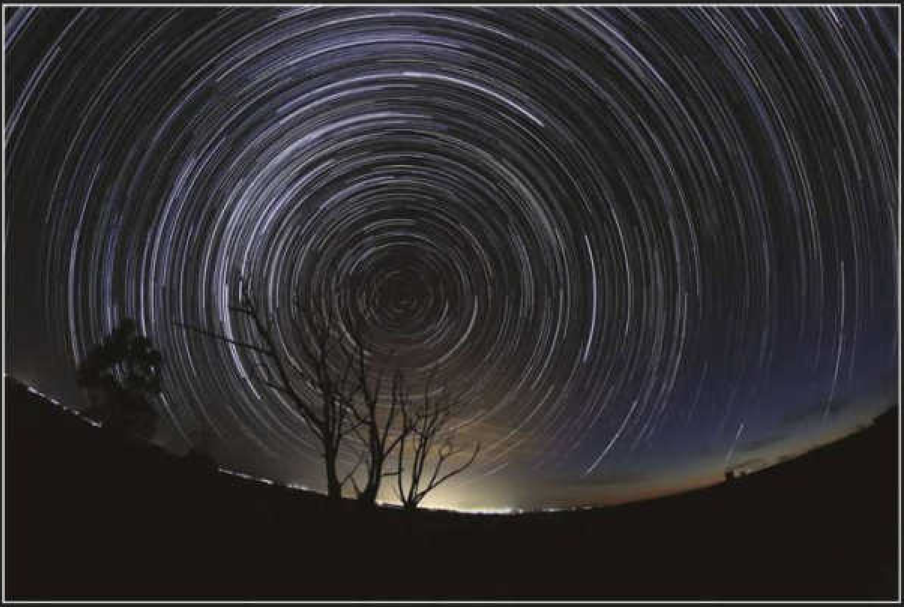
21 OCTOBER
Peak of the Orionid meteor shower

30 OCTOBER
End of daylight saving. Venus and Saturn 3° apart, low in the southwest after sunset

31 OCTOBER
It may be possible to spot a very thin Moon just after sunset

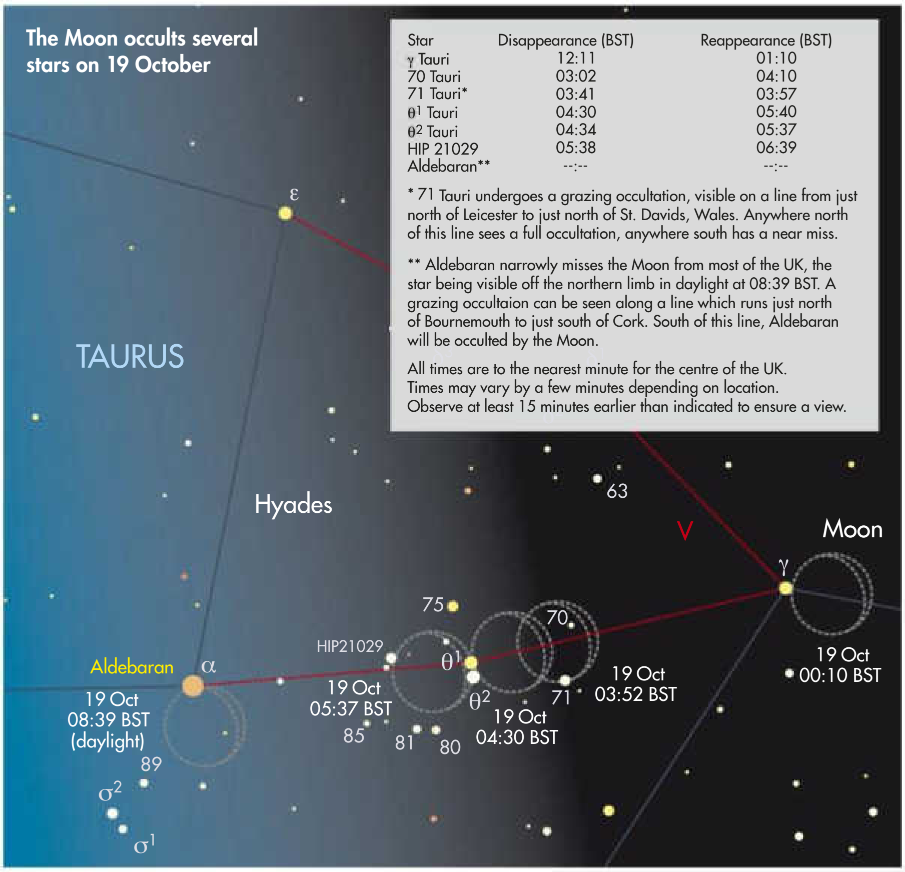
▼ HIGHLY COMMENDED
YOUNG ASTRONOMY PHOTOGRAPHER OF THE YEAR

Celestial Drift
Scott Carnie-Bronca, Australia – aged 13



OCTOBER at a glance

Seven Sisters shine overhead in a great month for stargazing



The Moon occults several stars on 19 October

Star	Disappearance (BST)	Reappearance (BST)
γ Tauri	12:11	01:10
70 Tauri	03:02	04:10
71 Tauri*	03:41	03:57
θ^1 Tauri	04:30	05:40
θ^2 Tauri	04:34	05:37
HIP 21029	05:38	06:39
Aldebaran**	--:--	--:--

* 71 Tauri undergoes a grazing occultation, visible on a line from just north of Leicester to just north of St. Davids, Wales. Anywhere north of this line sees a full occultation, anywhere south has a near miss.

** Aldebaran narrowly misses the Moon from most of the UK, the star being visible off the northern limb in daylight at 08:39 BST. A grazing occultaion can be seen along a line which runs just north of Bournemouth to just south of Cork. South of this line, Aldebaran will be occulted by the Moon.

All times are to the nearest minute for the centre of the UK.
Times may vary by a few minutes depending on location.
Observe at least 15 minutes earlier than indicated to ensure a view.

The autumn constellations of Pegasus, Pisces, Andromeda and Cetus take centre stage in the early part of the night. Pegasus is obvious due to a distinctive square asterism within it known as the Great Square of Pegasus. It's quite a large square which initially looks devoid of much else. Look hard however, and fainter stars may become visible to you inside its boundary. The number you can see varies depending on the quality of your sky.

Stretching out of the square's northeast corner is the wedge-shaped pattern of Andromeda. The wedge reaches across the sky towards Andromeda's mythological saviour, Perseus, the Greek Hero. His pattern looks a bit like a variant on a lower case Greek letter Pi (π). The brightest star here is mag +1.8 Mirfak (Alpha (α) Persei), which has a pretty semi-circle of stars around it to the southeast.

Cetus, the Whale or Sea Monster is a large, ill-defined constellation southeast of the Great Square. One of its brightest stars, mag. +2.0 Deneb Kaitos (Beta (β) Ceti), can be located by extending the line made by the eastern side of the Great Square south. At the other end of Cetus, a misshapen pentagonal pattern represents the whale's head. The brightest star here is mag. +2.5 Menkar (Alpha (α) Ceti), which shows a definite orange colour.

The constellation of Taurus, the Bull lies east of Menkar and includes the distinctive Pleiades open cluster, M45. The many stars that form this hot, young cluster really vie for your attention on a clear, dark October night. The informal name for the Pleiades is the Seven Sisters, but if you have good eyesight and dark skies it's often quite easy to see far more than seven. Take a look and see how many you can count.

Southeast of the Pleiades is the V-shaped Hyades cluster representing the face of the bull, with the point of the V marking his nose and the bright orange star mag. +0.8 Aldebaran (Alpha (α) Tauri) at the end of the V's southern arm representing his eye. The name Aldebaran means 'follower' and is thought to refer to the way it appears to follow the Pleiades across the sky.

Aldebaran is actually about half the distance of the Hyades from us, so not a true member of the cluster at all. Extend the arms of the V to the east, and you'll eventually come to two stars which mark the bull's horn tips. Taurus represents the head, horns and upper torso of a bull, the Pleiades mark his shoulder.

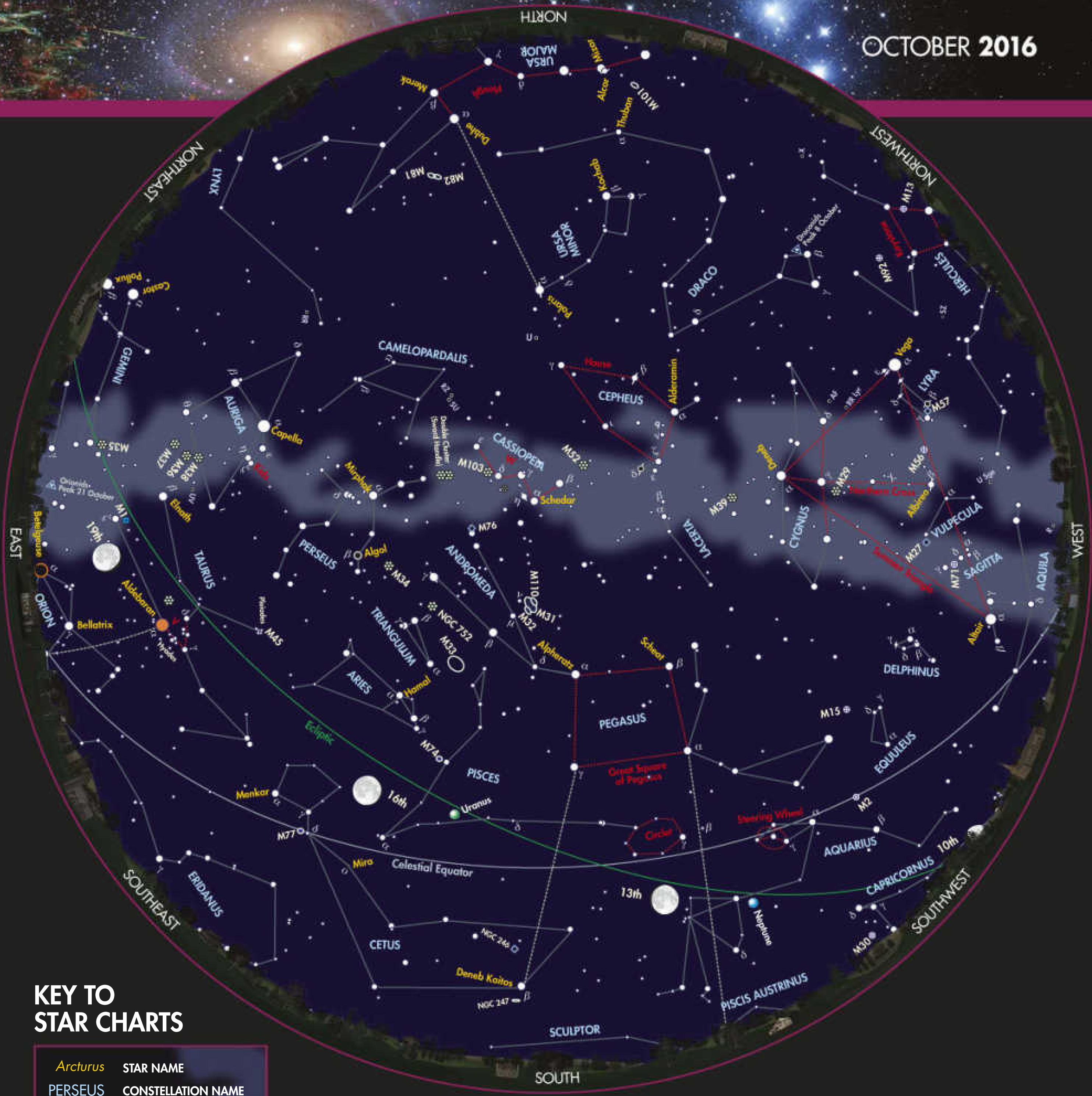
The northern horn tip star is mag. +1.6 Elnath (Beta (β) Tauri) which used to belong to the constellation of Auriga to the north. This constellation is best described as looking like a misshapen pentagon, and is picked out by the beautiful yellow-coloured star mag. +0.1 Alpha (β) Aurigae, or Capella, at its top. A binocular sweep through the pentagon reveals numerous star clusters in the Milky Way, which runs through Auriga.

October also re-introduces an old friend in the form of Orion, the Hunter rising in the east and gaining a decent height later in the night. The annual Orionid meteor shower peaks this month, on the night of 21-22. The shower occurs when Earth passes through the debris stream strewn around comet Halley's orbit. A full Moon on 22 October will mean this year's display will be diminished somewhat. Even so, it's worth keeping an eye on the sky, perhaps placing the bright Moon behind a tree or house. Although fainter meteors will be hidden from view, a bright Orionid fireball will more than make up for this.

An Orionid meteor in Orion. The radiant position is close to the star Betelgeuse, the Hunter's left shoulder. This year's display will be affected by the almost-full Moon

PETE LAWRENCE X 3

OCTOBER 2016



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←	MILKY WAY
	PLANET

STAR BRIGHTNESS:

MAG. 0 & BRIGHTER · MAG. +1 · MAG. +2 · MAG. +3 · MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Well placed in morning at the start of October. Very close to Jupiter on the 11th but soon lost from view

VENUS
Well separated from the Sun but poorly placed in the evening sky. Close to Saturn at end of month

MARS
Remains low but visible all month long

JUPITER
Morning object. A 4% waning crescent Moon is 40 arcminutes north of Jupiter at 10:00 UT on 28 October

SATURN
Too low in the evening sky for serious observation

URANUS
At opposition on 15 October, visible all night long. Full Moon is close during the morning of 16 October

NEPTUNE
Continues to be well placed throughout October

MOON PHASES Key stages in the monthly cycle

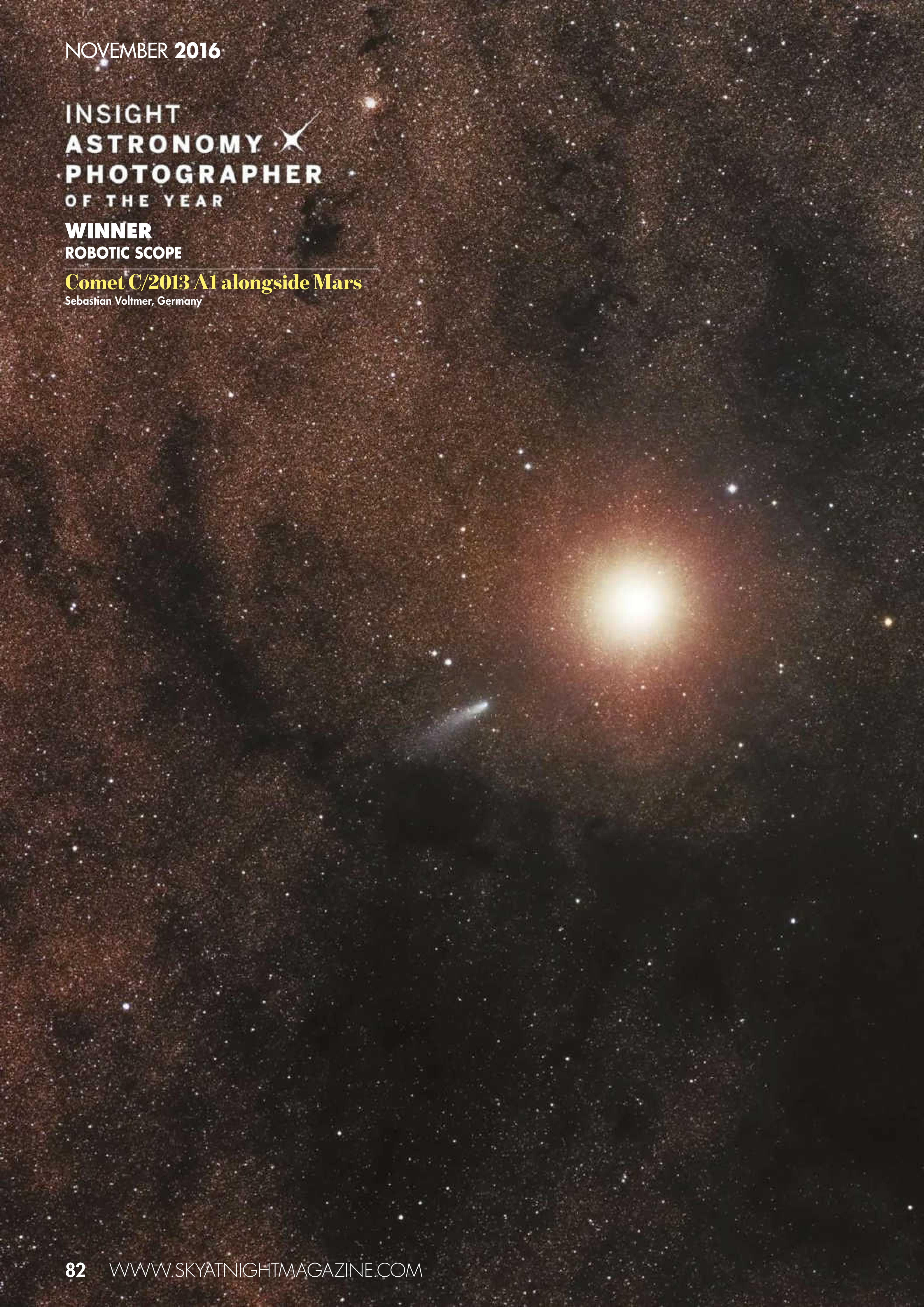
NEW MOON
1 Oct

FIRST QUARTER MOON
9 Oct

FULL MOON
16 Oct

LAST QUARTER MOON
22 Oct

NEW MOON
30 Oct



INSIGHT ASTRONOMY PHOTOGRAPHER OF THE YEAR

WINNER
ROBOTIC SCOPE

Comet C/2013 A1 alongside Mars

Sebastian Voltmer, Germany

November

Dramatic constellations
take over the skies as
the nights grow cold

KEY DATES

ALL MONTH
Minor planet Vesta tracks towards the Beehive Cluster, M44. It's closest at the end of the month

4 NOVEMBER
A 21% waxing crescent Moon occults part of the open cluster M25. View as soon as it gets dark

14 NOVEMBER
A perigee-syzygy full Moon; the closest and largest of the year

17 NOVEMBER
Peak of the annual Leonid meteor shower

30 NOVEMBER
An opportunity to spot a 1% illuminated waxing crescent Moon just after sunset

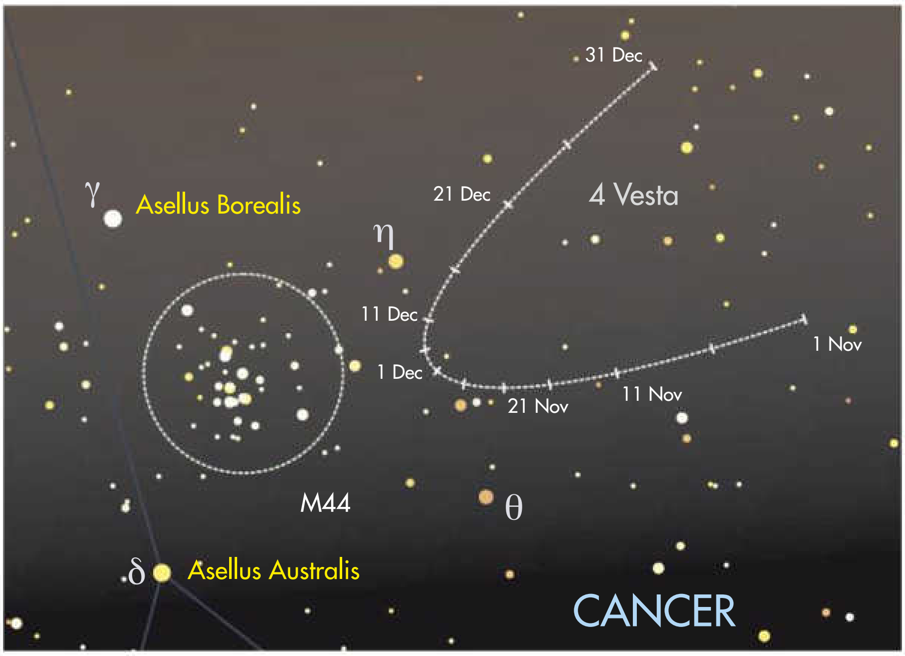
▼ HIGHLY COMMENDED
AURORAE

Sumo Waggle Adventure
Arild Heitmann, Norway

NOVEMBER at a glance

Enjoy the largest full Moon of the year at perigee-syzygy

With long, dark nights on offer, November is a great month to do astronomy. Early evening, the stars of autumn take centre stage, with the Great Square of Pegasus two thirds of the way up the sky in the south. Many of the constellations below it are faint and can be too subtle to pick out. Immediately below the Great Square is the asterism known as the Circlet, part of Pisces. To the southwest is the faint and ill-defined Aquarius, and further east, Cetus.



Position of the Asteroid Belt's minor planet Vesta at five-day intervals, correct for 00:00 UT

In the period coming up to midnight, these subtle constellations give way to the more dramatic patterns that dominate the winter sky. These fill the region east of south with Orion, the Hunter being the most obvious. His three belt stars are easy to identify and from here you can easily imagine the hunter's shoulders and lower body.

Follow the line of the belt stars northeast and they point to the bright orange star mag. +0.8 Aldebaran (Alpha (α) Tauri), representing the eye of Taurus, the Bull. The V-shaped Hyades open cluster, the closest open cluster to Earth, is east of Aldebaran; the V being on its side. Follow the line from Orion's belt, through Aldebaran and keep going to arrive at the wonderful Seven Sisters open cluster, also known as the Pleiades. Despite being three times further away than the Hyades, this group of young, hot stars is even more prominent than its older sky neighbour.

River of stars

The region southeast of Orion is filled with the meandering pattern of stars of Eridanus, the River. This fills the large region between Orion and Cetus. Made up mostly of faint stars, Eridanus can be hard to make out. From the UK, it flows from close to mag. +0.2 Rigel (Beta (β) Orionis) in Orion to the west then curves round to the east. We just get to see the start of another bend to the west from the UK, but then the river is cut off by the southern horizon. This is a pity, because the best part of Eridanus is just below the horizon: the really bright mag. +0.4 Achernar (Alpha (α) Eridani), one of the jewels of the southern sky.

Immediately to the south of Orion is a small pattern of stars that looks a bit like the mathematical symbol for infinity (∞) with two ears. This is Lepus, the Hare, an unfortunate creature being chased across the heavens by Orion and his entourage.

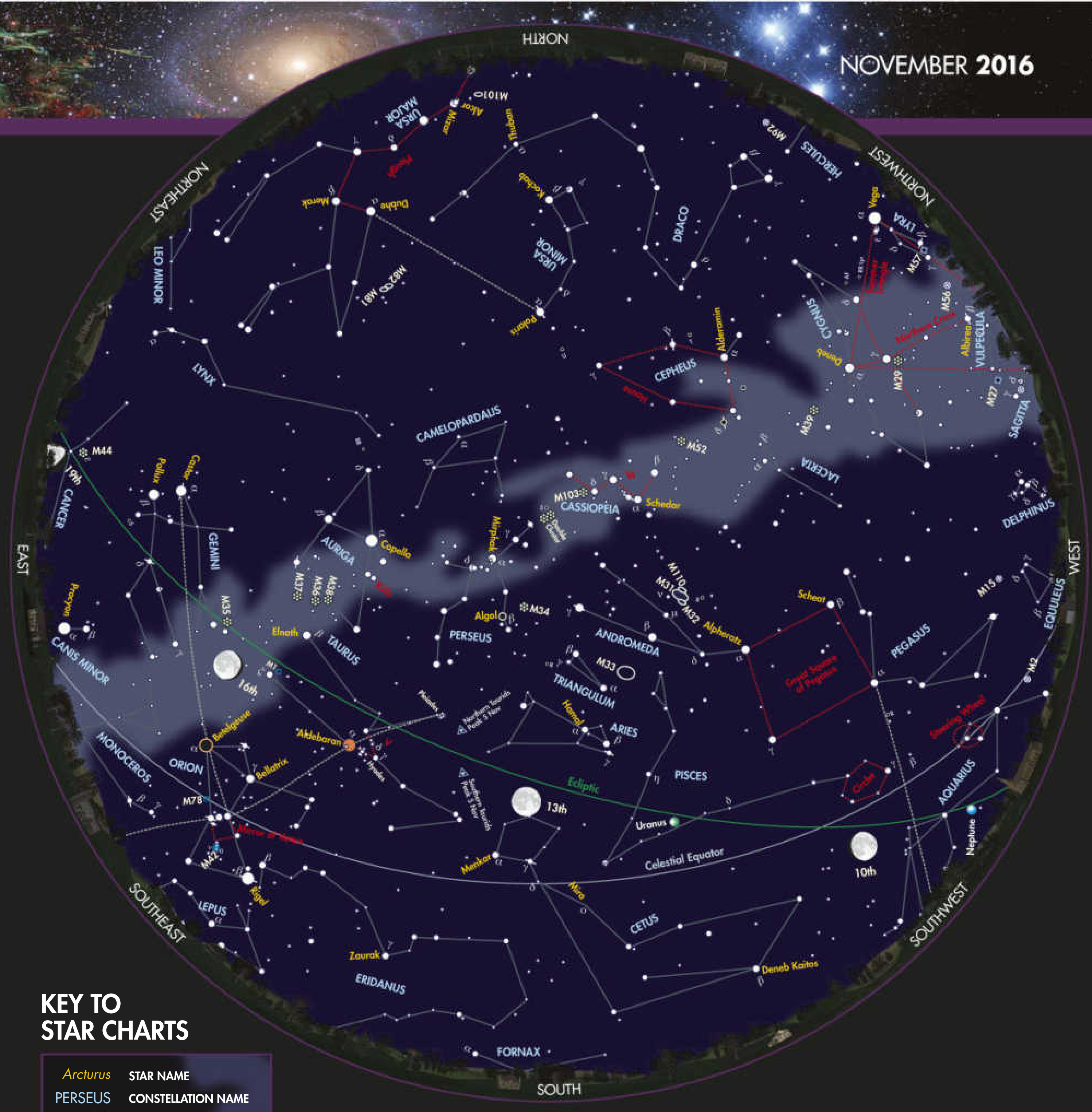
This month's full Moon occurs when the Moon's at perigee and closest to Earth

PETE LAWRENCE X 3

The middle of the month will be punctuated by a bright full Moon. This large, bright Moon will unfortunately have a detrimental effect on the appearance of the annual Leonid meteor shower, which peaks on the night of 17-18 November.

During the months around the winter solstice, which this year occurs on 21 December, the fuller phases of the Moon rise high in the sky. Just to compound matters, the full Moon on 14 November will coincide with the Moon being at perigee in its orbit. Perigee is the point in an elliptical orbit around Earth where the orbiting body is at its closest point to us. At full Moon, the Sun, Earth and Moon are in a line, a configuration described by the astronomical term 'syzygy'. So this is technically known as a perigee-syzygy Moon and the largest full Moon of the year. Despite this, it will only appear marginally larger than it was last month!

NOVEMBER 2016



KEY TO STAR CHARTS

Arcturus	STAR NAME
PERSEUS	CONSTELLATION NAME
⬭	GALAXY
◌ ❄	OPEN CLUSTER
⊕	GLOBULAR CLUSTER
⌑	PLANETARY NEBULA
□	DIFFUSE NEBULOSITY
●	DOUBLE STAR
○	VARIABLE STAR
◐	THE MOON (SHOWING PHASE)
☄	COMET TRACK
☄	ASTEROID TRACK
⋯	STAR-HOPPING PATH
△	METEOR RADIANT
Circlet	ASTERISM
←	MILKY WAY
🪐	PLANET

STAR BRIGHTNESS:

●	●	•	•	·
MAG. 0 & BRIGHTER	MAG. +1	MAG. +2	MAG. +3	MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
Evening planet but poorly placed and unlikely to be seen

VENUS
Evening planet, rather low after sunset. Best seen at the end of November

MARS
Maintains the same relative position against the southern horizon all month. Best on the 1st

JUPITER
Morning planet, improving in position. A 15% waning crescent Moon is close as both objects rise on the 25th

SATURN
Heading into the Sun's glare and lost from view at the end of the month

URANUS
Well placed, close to Zeta and 88 Piscium and close to the threshold of naked eye visibility

NEPTUNE
Well placed in Aquarius, 2.5° southwest of mag. +3.7 Lambda (λ) Aquarii

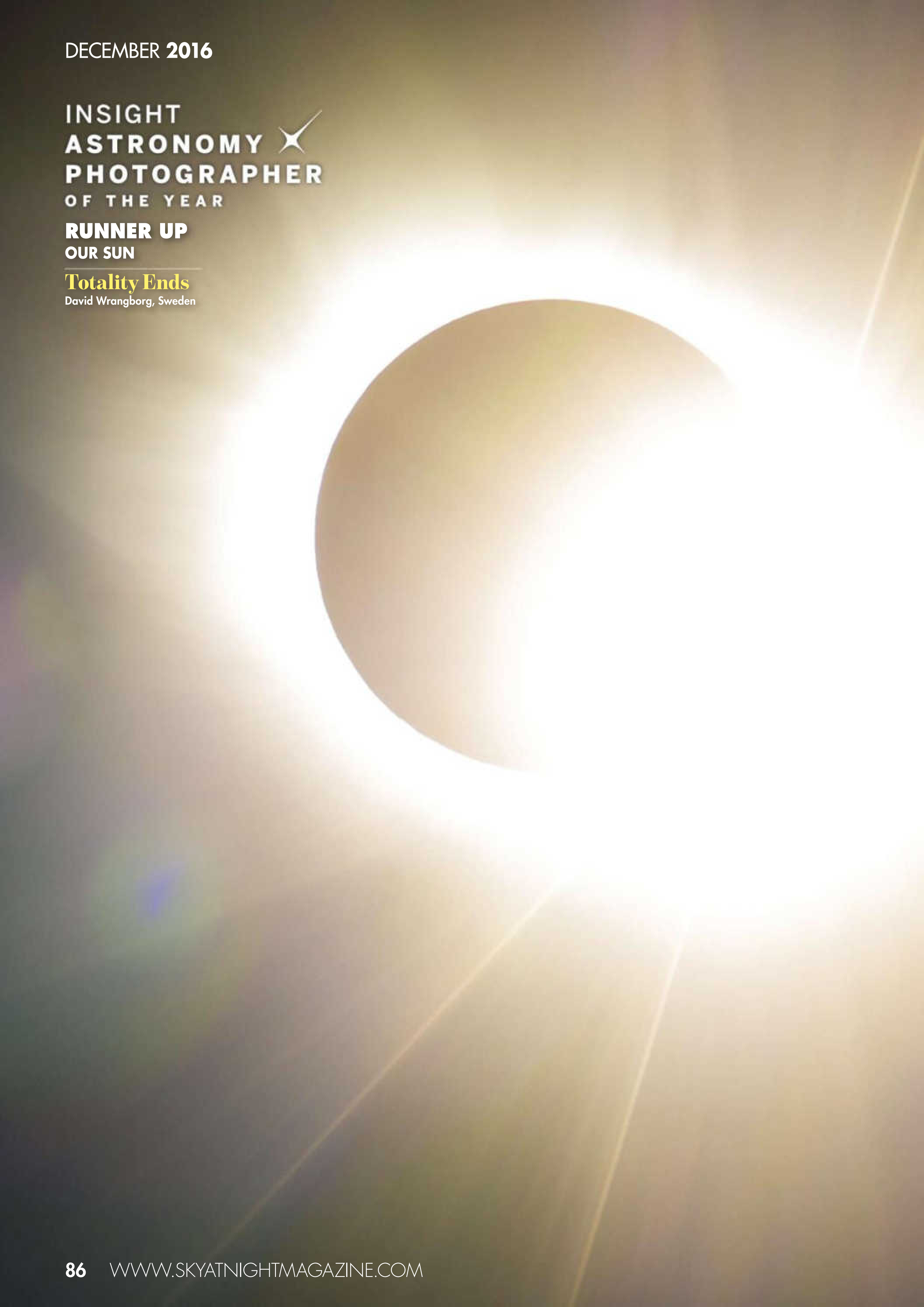
MOON PHASES Key stages in the monthly cycle

FIRST QUARTER MOON
7 Nov

FULL MOON
14 Nov

LAST QUARTER MOON
21 Nov

NEW MOON
29 Nov



INSIGHT ASTRONOMY PHOTOGRAPHER OF THE YEAR

RUNNER UP

OUR SUN

Totality Ends

David Wrangborg, Sweden

December

Watch out for two meteor showers on this month's long cold nights

KEY DATES

6 DECEMBER
A 44% waxing crescent Moon occults Neptune around 22:30 UT

12-13 DECEMBER
The almost full Moon passes through the Hyades from 21:20 UT, occulting Aldebaran around 05:20 UT on the 13th

13 DECEMBER
Peak of the annual Geminid meteor shower – a bright full Moon will interfere

21 DECEMBER
The Northern Hemisphere's winter solstice occurs at 10:44 UT

21/22 DECEMBER
Peak of the annual Ursid meteor shower

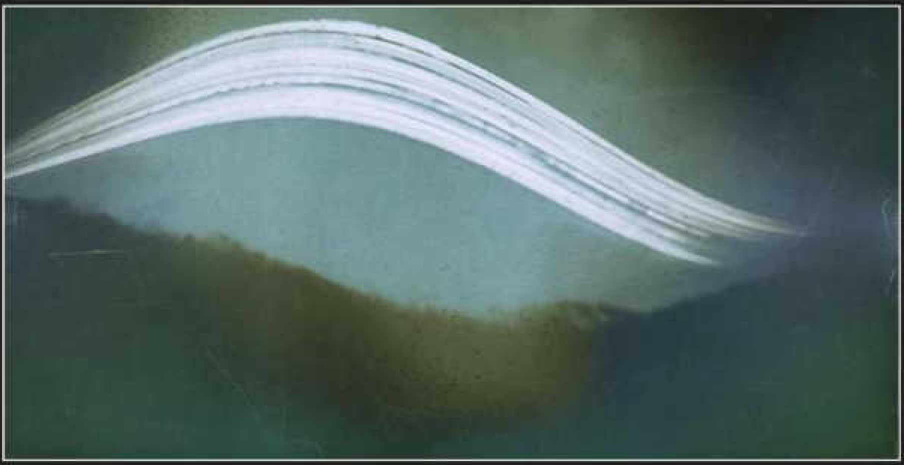
31 DECEMBER
Mars and Neptune will be very close as darkness falls

▼HIGHLY COMMENDED

OUR SUN

Solargraph – Six Months

Chris Bakley, USA



DECEMBER at a glance

Neptune slips behind the Moon as the year comes to an end

6 DECEMBER
Neptune disappears behind the Moon's disc at 22:35 UT (followed by its moon Triton 45 seconds later). We've deliberately made the sky brighter to show you where Neptune will be relative to the lit portion of the Moon's disc. This time will vary by location so view from at least 15 minutes earlier to ensure you can find Neptune. The Moon will be very low at this time, four degrees up in the west-southwest

December carries the year's theme of transits and occultations to a conclusion with a lunar occultation of Neptune, visible on 6 December, and a lovely occultation of some of the Hyades stars on the night of December 12-13. This event reaches a climax with the Moon passing in front of the bright star mag. +0.8 Aldebaran (Alpha (α) Tauri) at around 05:20 UT on the 13th.

Back to the stars and December places mighty Orion, the Hunter, at centre stage. This is a great time for the hunter to be in this position too, as the nights of December are the longest of the year. This means there are plenty of opportunities to sample the delights that lie within and around Orion's borders.

Three similar brightness stars, equally spaced in a straight line, form Orion's belt. Hanging down from this is a north-south line of fainter stars which represents his sword. Point a pair of binoculars at Orion's sword, and its true beauty will be revealed. The region is formed from several star clusters and regions of nebulosity, the most famous of which is the Orion Nebula, M42. This is a magnificent glowing cloud of gas which represents a region of space where stars are being born. A small cluster of stars can be seen within the nebula. Known as the Trapezium Cluster, these stars have been born out of the nebula material and their light excites the surrounding gas, causing the nebula to glow.

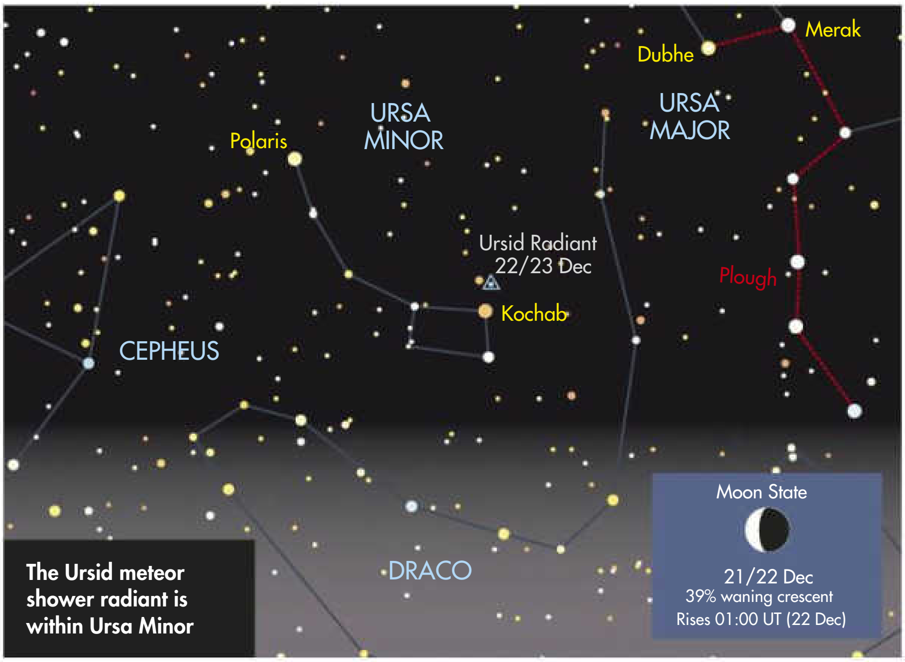
Hunting the twins

Follow Orion's belt stars southeast to mag. –1.5 Sirius (Alpha (α) Canis Majoris), the brightest night-time star of them all. On a cold December night, Sirius appears to flash distinct colours. This is due to the white light of the star passing through the distorting and turbulent atmospheric layer found closer to the horizon. From the UK, Sirius only manages to attain a height of around 20° when due south, so the effect is quite pronounced.

Sirius is the brightest star in Canis Major. This is a lovely constellation, depicting one of Orion's hunting dogs. Its shape does look like a dog, but only when you realise it's running up the sky to its master. The middle-brightness star immediately to the west of Sirius is mag. +2.0 Mirzam (Beta (β) Canis Majoris) and represents one of the dog's front paws.

The winter Milky Way passes up the sky to the left of Sirius and through the dim constellation of Monoceros, the Unicorn, towards the bright orange mag. +0.4 Betelgeuse (Alpha (α) Orionis). This marks the eastern shoulder of the hunter.

Here the Milky Way passes between Betelgeuse and the feet of the twins, Castor and Pollux, who are represented by the constellation Gemini. Extend the line from mag. +0.2 Rigel (Beta (β) Orionis) in the southwest of Orion, through Betelgeuse for about twice the distance again to arrive at the two main stars in Gemini. These are named after the mythological twins, with mag. +1.6 Castor (Alpha (α) Geminorum) to the north and mag. +1.2 Pollux (Beta (β) Geminorum) to the south.

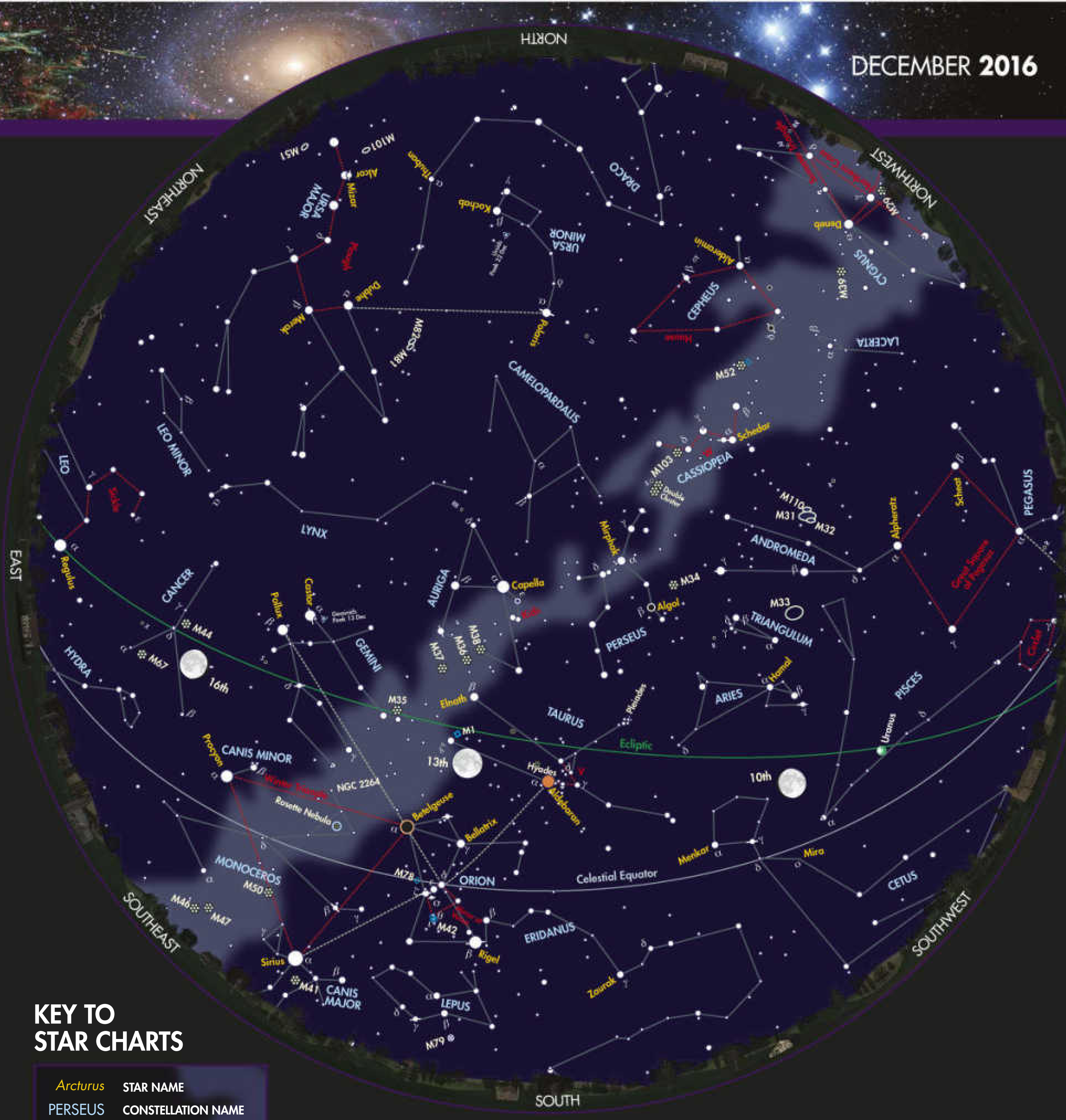


The Ursid meteor shower radiant is within Ursa Minor

Moon State
21/22 Dec
39% waning crescent
Rises 01:00 UT (22 Dec)

PETE LAWRENCE X 3

DECEMBER 2016



KEY TO STAR CHARTS

Arcturus STAR NAME
PERSEUS CONSTELLATION NAME
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THE MOON (SHOWING PHASE)
COMET TRACK
ASTEROID TRACK
STAR-HOPPING PATH
METEOR RADIANT
Circlet ASTERISM
MILKY WAY
PLANET

STAR BRIGHTNESS:

MAG. 0 & BRIGHTER
MAG. +1
MAG. +2
MAG. +3
MAG. +4 & FAINTER

VISIBLE PLANETS Where to spot the planets this month

MERCURY
An evening planet, reaching greatest eastern elongation on 11 December. Best visibility is on the 17th

VENUS
In the evening sky, best at the end of the month when, telescopically, it'll be showing a 50% phase

MARS
Maintains position in the evening sky, visible low in the south-southwest as darkness falls

JUPITER
Improves through the month. Waning crescent Moon is close on the mornings of 22nd and 23rd

SATURN
In conjunction with the Sun on the 10th. It may just be visible in the morning sky before sunrise on the 31st

URANUS
Well positioned all month, forming a very tight triangle with mag. +5.2 Zeta (ζ) and +6.0 88 Piscium

NEPTUNE
Best placed at the start of December, occulted by the Moon on the 6th. Mars very close on 31st

MOON PHASES Key stages in the monthly cycle

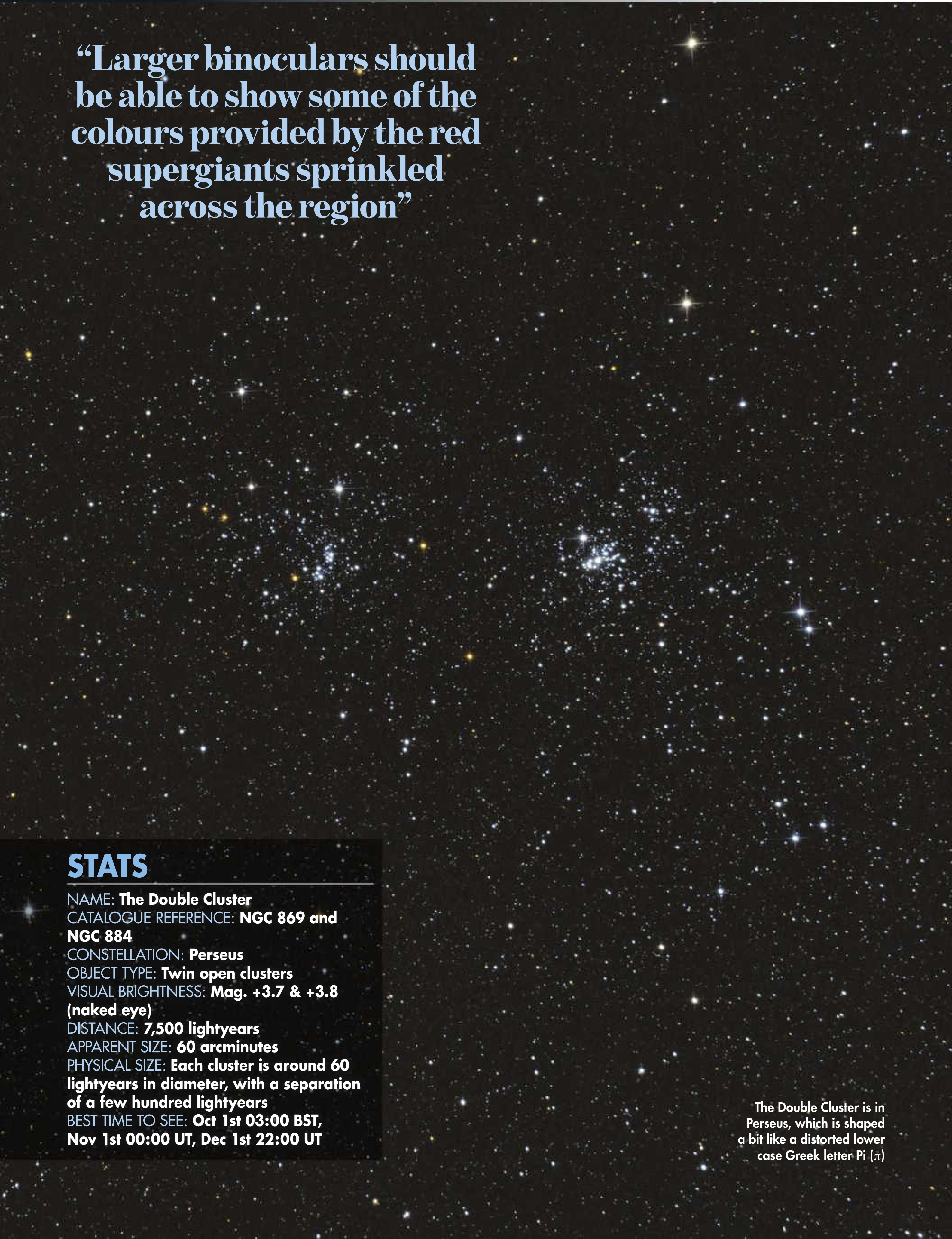
FIRST QUARTER MOON
7 Dec

FULL MOON
14 Dec

LAST QUARTER MOON
21 Dec

NEW MOON
29 Dec

> “Larger binoculars should be able to show some of the colours provided by the red supergiants sprinkled across the region”



The Double Cluster is in Perseus, which is shaped a bit like a distorted lower case Greek letter Pi (π)

STATS

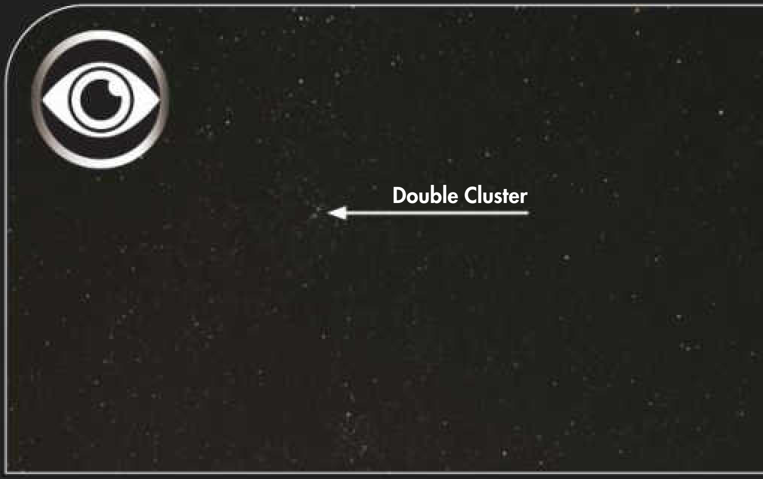
NAME: **The Double Cluster**
CATALOGUE REFERENCE: **NGC 869 and NGC 884**
CONSTELLATION: **Perseus**
OBJECT TYPE: **Twin open clusters**
VISUAL BRIGHTNESS: **Mag. +3.7 & +3.8 (naked eye)**
DISTANCE: **7,500 lightyears**
APPARENT SIZE: **60 arcminutes**
PHYSICAL SIZE: **Each cluster is around 60 lightyears in diameter, with a separation of a few hundred lightyears**
BEST TIME TO SEE: **Oct 1st 03:00 BST, Nov 1st 00:00 UT, Dec 1st 22:00 UT**

NGC 869 AND NGC 884
THE DOUBLE CLUSTER

Two clusters both alike in dignity, in fair Perseus where we lay our scene

NAKED EYE The view from the ground

Perseus is a constellation representing the Greek hero who saved Princess Andromeda from a sea monster. Andromeda's mother Queen Cassiopeia has her own constellation too, and a line from Gamma (γ) to Delta (δ) Cassiopeiae, extended about the same distance again, points at the Double Cluster, a pair of very similar open clusters called h and Chi (χ) Persei. The faint smudges that can be seen with the naked eye represent the handle of Perseus' sword, so they are also known as the Sword Handle. Our best times to see the Double Cluster represent the times when it's highest in the sky, virtually overhead. However, this is a circumpolar object, which never sets from the latitude of the UK, so it's visible whenever the sky is dark and clear.

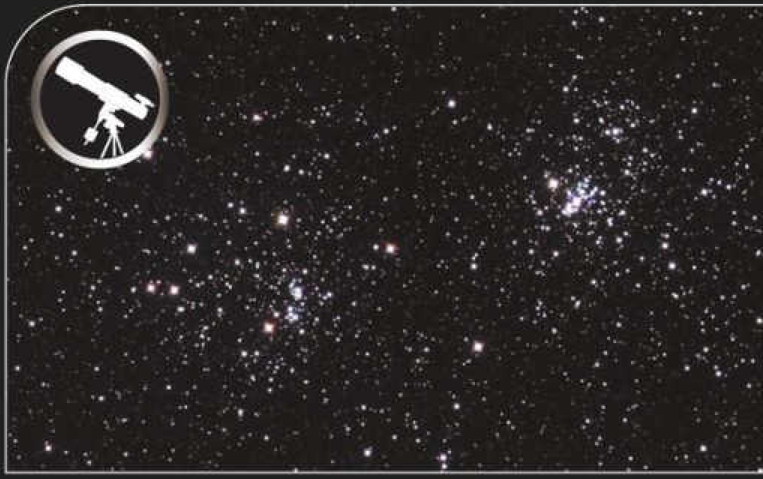


BINOCULARS Getting a closer look

Binoculars really bring the Double Cluster to life. Where the naked eye sees an elongated smudge, binoculars reveal a veritable explosion of stars centred around the common centres of both objects. Larger binoculars should be able to show some of the impressive colours provided by the red supergiants sprinkled across the region. The eastern cluster, Chi, seems most colourful. Two mag. +8.0 red stars can be seen between h and Chi, and three are peppered across Chi itself. There's a pair of red stars separated by two arcminutes to the east of Chi's core which work together, enhancing their red glow and making a beautiful contrast to the blue-white stars that make up the bulk of the cluster.

TELESCOPE Seeing all the detail

Despite their large apparent size, h and Chi Persei remain wonderful objects to examine with a telescope. A low power eyepiece will produce a breathtaking view, especially if you can get both clusters in the same field of view. The extra light-gathering power helps enhance the colours on view, and again it's the red supergiants that really stand out. The stars should resolve easily even with small telescopes, and this provides a wonderful opportunity to compare the clusters. Chi Persei appears slightly larger, with brighter stars over a marginally wider area. Conversely, the core of h is better defined, with a tight concentration of mostly eighth and ninth magnitude stars, and one mag. +6.6 star giving it a concentration bias.



ISTOCK, PETE LAWRENCE X 3

INSIGHT ASTRONOMY PHOTOGRAPHER OF THE YEAR

HIGHLY COMMENDED AND SHORTLISTED GALLERIES

You've seen our pick of the highly commended images on the opening pages of our monthly guides for October, November and December. Now see the rest, plus our favourite shortlisted images

THE JUDGES

Chris Lintott
Presenter, *The Sky at Night*

Maggie Aderin-Pocock
Presenter, *The Sky at Night*

Pete Lawrence
Presenter, *The Sky at Night*

Marek Kukula
Public Astronomer, Royal Observatory Greenwich

Melanie Vandenbrouck
Curator of Art, Royal Museums Greenwich

Chris Bramley
Editor, *BBC Sky at Night Magazine*

Jon Culshaw
Comedian and *BBC Sky at Night Magazine* contributor

Will Gater
Astronomy journalist and author

Ed Robinson
Photographer and director

With 2,700 entries from across the globe, the judges of 2015's Insight Astronomy Photographer of the Year competition had a tough job deciding the winners. The standard of entries to the contest, organised by the Royal Observatory Greenwich and supported by *BBC Sky at Night Magazine*, was incredibly high, with images ranging from stunning portraits of comets and galaxies to artistic shots showing Earth's place in the cosmos. This year also saw the sponsorship of Insight Investment.

Images were judged across eight categories, including Aurorae, Galaxies, Our Sun, Stars and Nebulae, and People and Space, with two special prizes also awarded.

Throughout this Yearbook we've featured the winning images, and over the next seven pages showcase the shortlisted photographs the judges chose to be in the running for the top prizes.

www.rmg.co.uk/astrophoto

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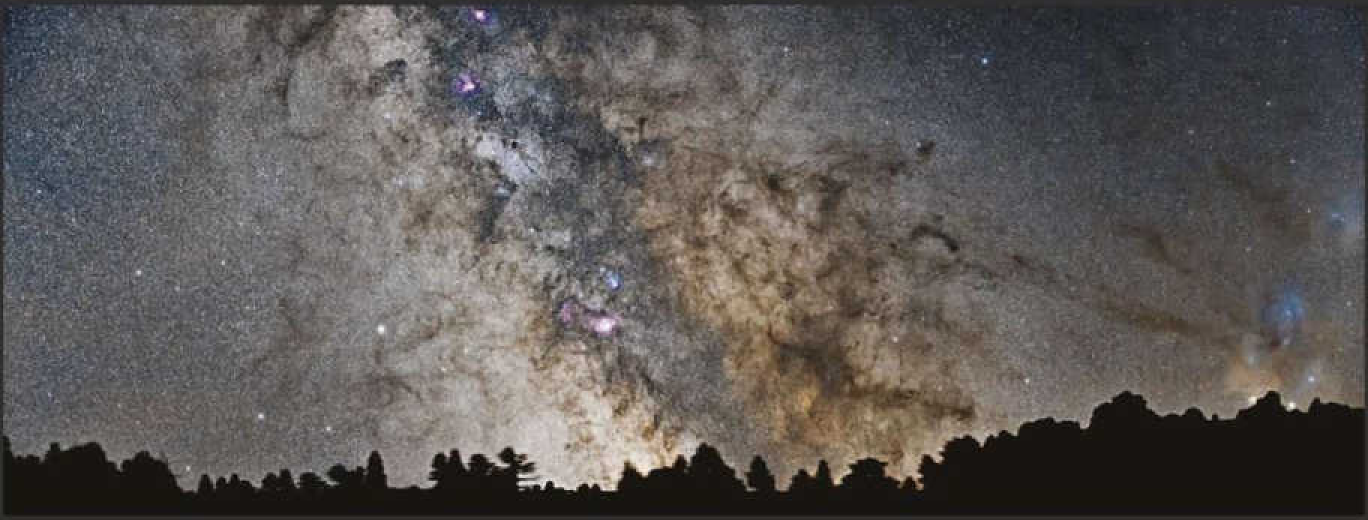
HIGHLY COMMENDED



▲ SKYSCAPES SPONSORED BY INSIGHT INVESTMENT

RIVER OF LIGHT

Martin Campbell, UK

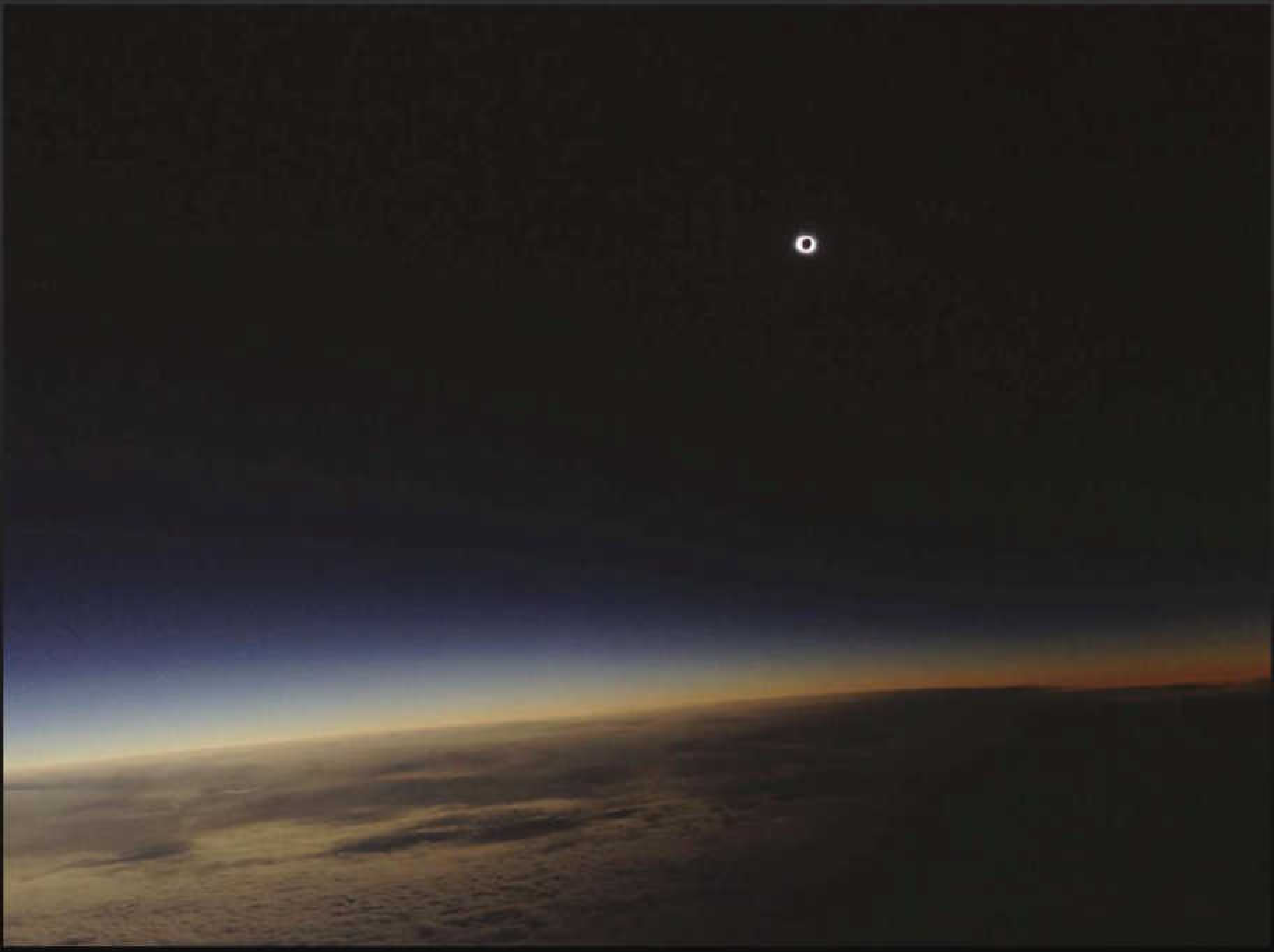
Equipment: Canon EOS 5D Mk II DSLR camera, Canon 85mm lens, Vixen Photo Guider mount

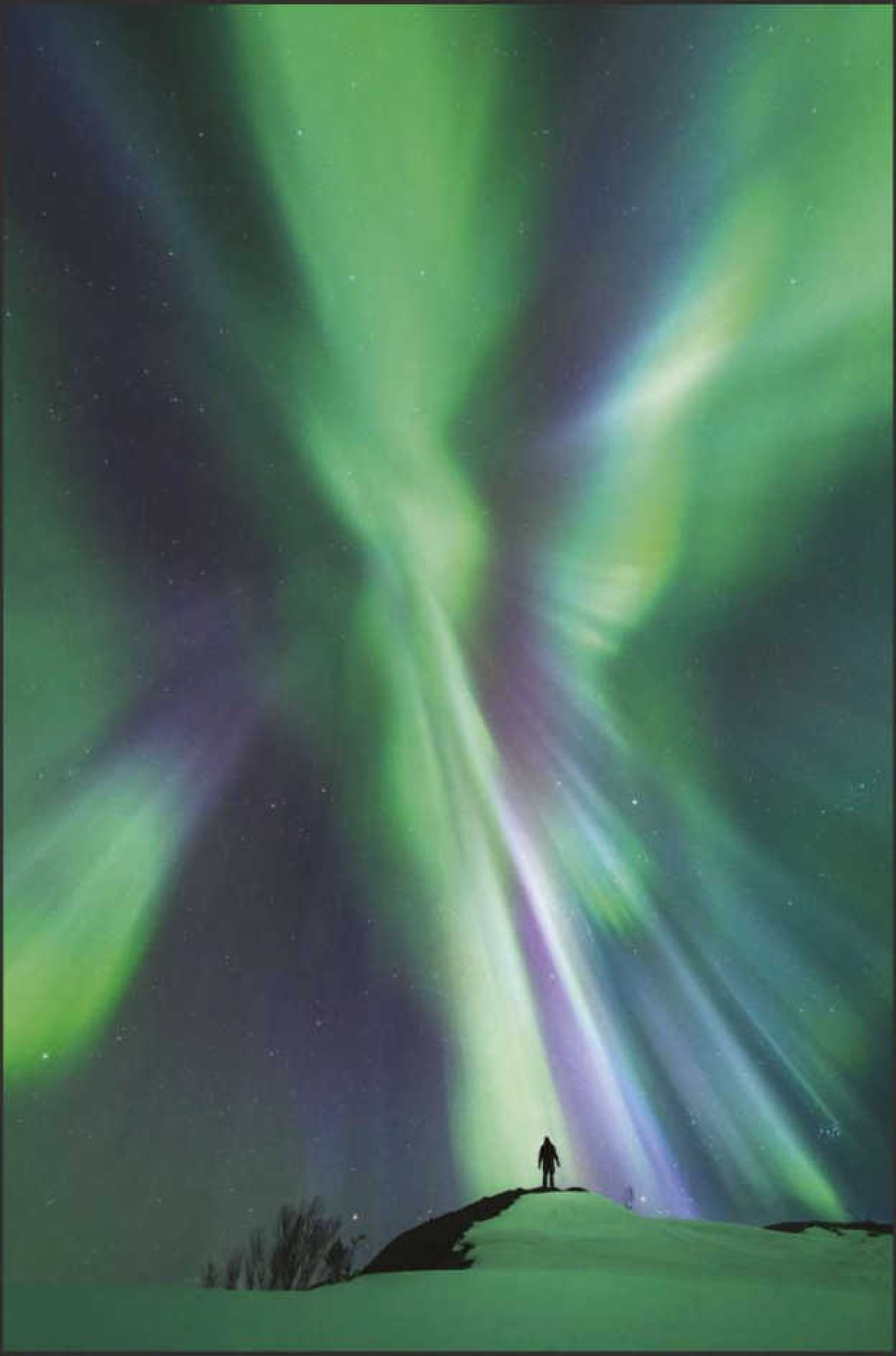
▼ YOUNG ASTRONOMY PHOTOGRAPHER OF THE YEAR

TOTAL SOLAR ECLIPSE OVER NORTH ATLANTIC OCEAN

Philippe Rowland, UK – aged 7

Equipment: iPad mini camera





◀ PEOPLE & SPACE

INTERACTION

Tommy Eliassen, Norway

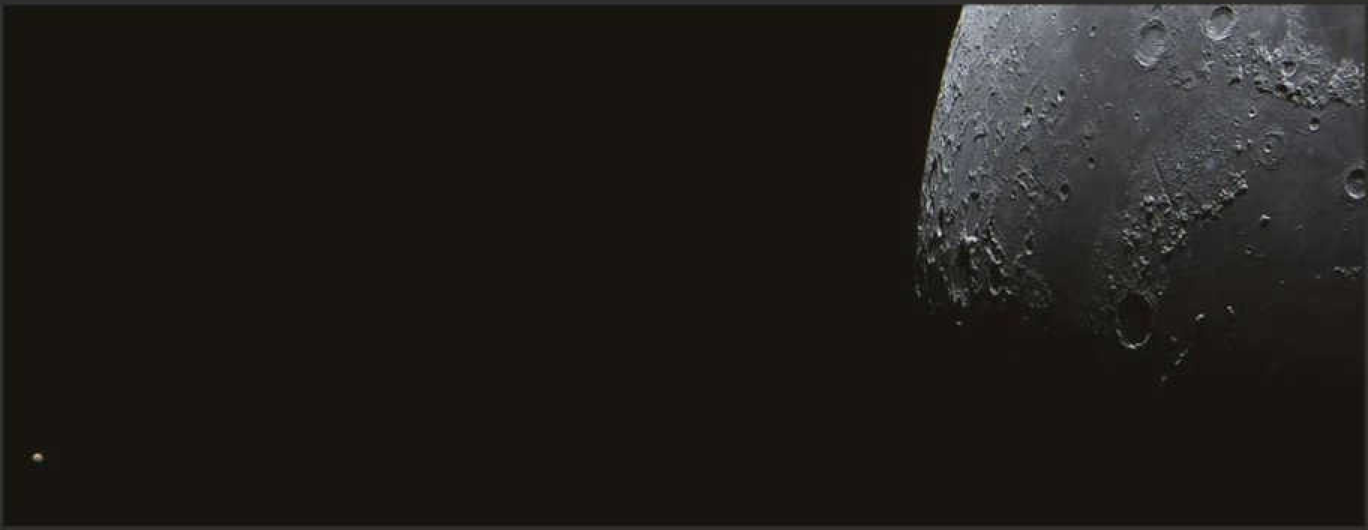
Equipment: Nikon D800 DSLR camera, 14mm lens

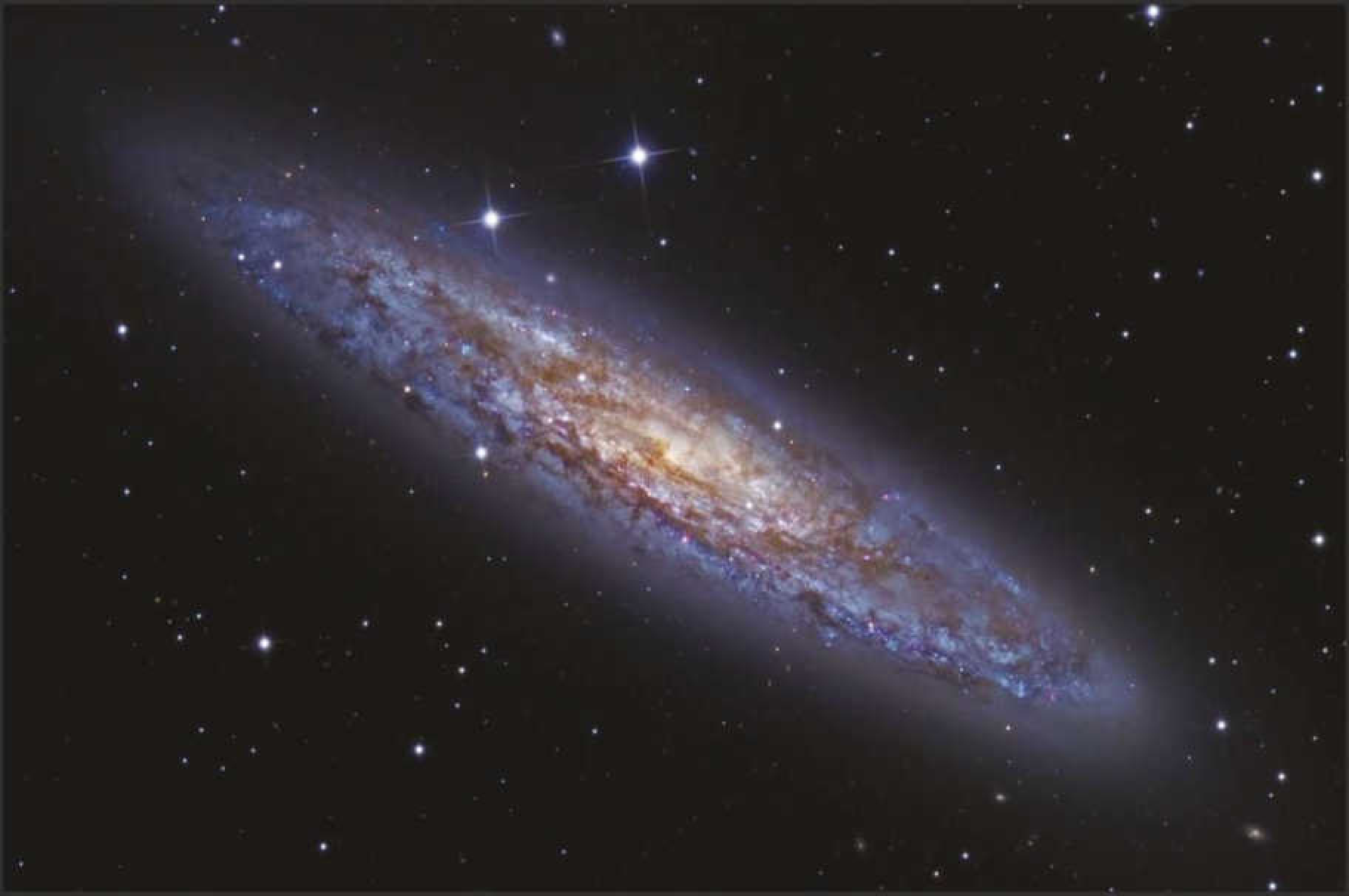
▼ PLANETS, COMETS & ASTEROIDS

MARS NEXT TO THE MOON

Eric Toops, USA

Equipment: Point Grey video camera, Meade APO refractor, EQ6 mount



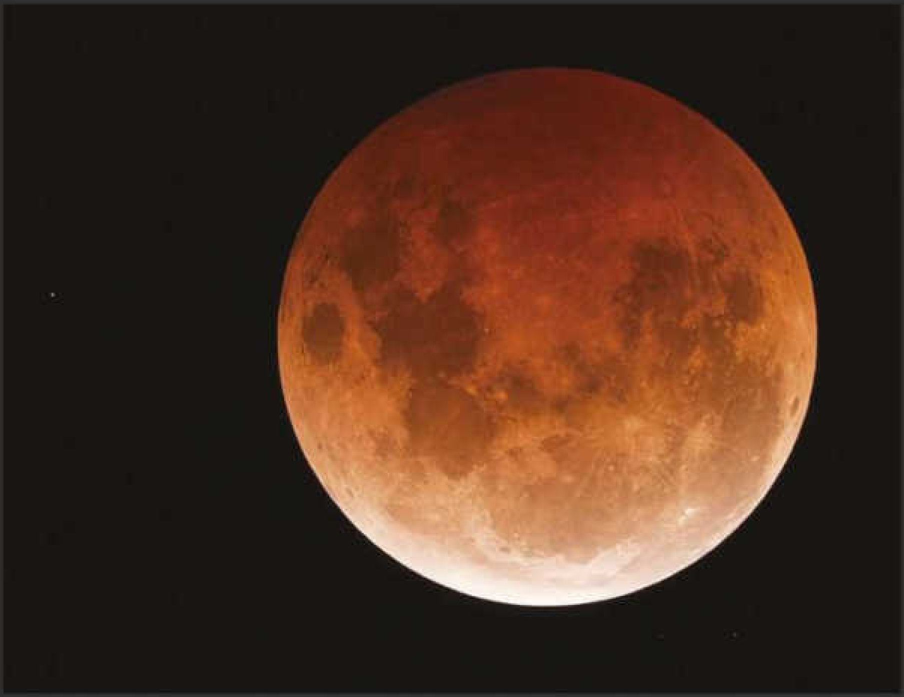


▲ GALAXIES

COSMIC OASIS

Marcus Davies, Australia

Equipment: SBIG STL11000M CCD camera, Officina Stellare 14-inch Ritchey-Chrétien, Paramount ME mount

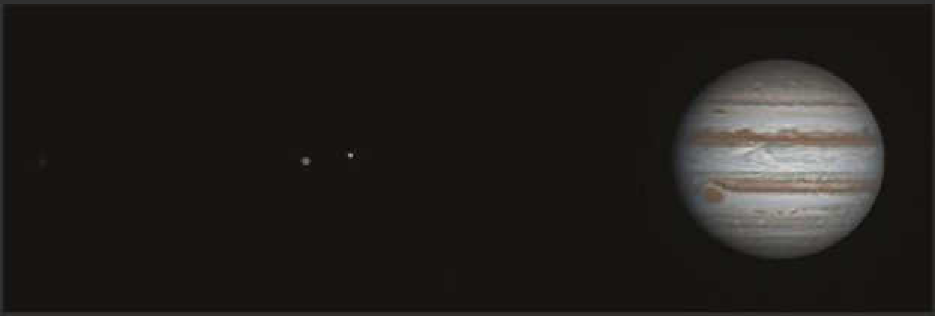


▼ YOUNG ASTRONOMY PHOTOGRAPHER OF THE YEAR

JUPITER AND MOONS

Ethan Chappel, USA – aged 15

Equipment: ASI174MM mono camera, Celestron Edge HD 11-inch Schmidt-Cassegrain, CGEM DX mount



▲ OUR MOON

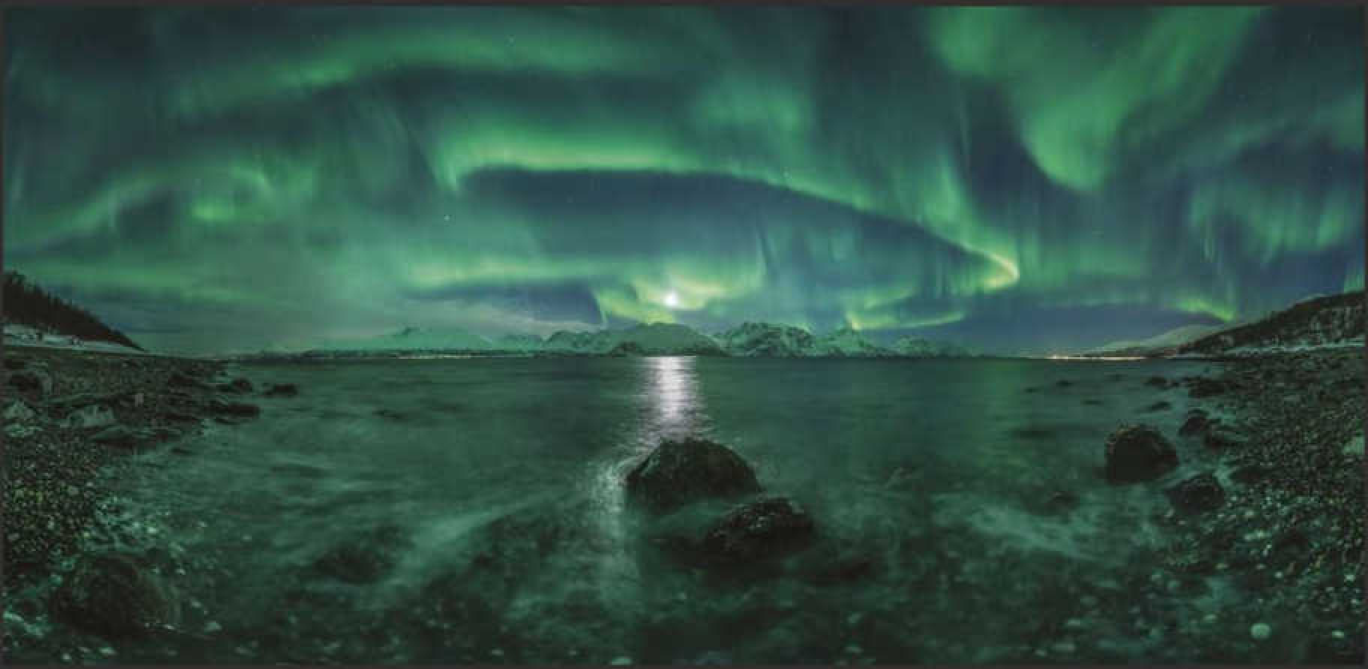
A TAINTED ECLIPSE

Phil Hart, Australia

Equipment: Canon EOS 6D DSLR camera, Takahashi FS-102 refractor, AZ EQ6 mount

SHORTLISTED

A total of 130 pictures were shortlisted across eight categories this year. Here are *BBC Sky at Night Magazine's* favourites from each category



▲ AURUROE

AURORA PANORAMA 3

Jan R. Olsen, Norway

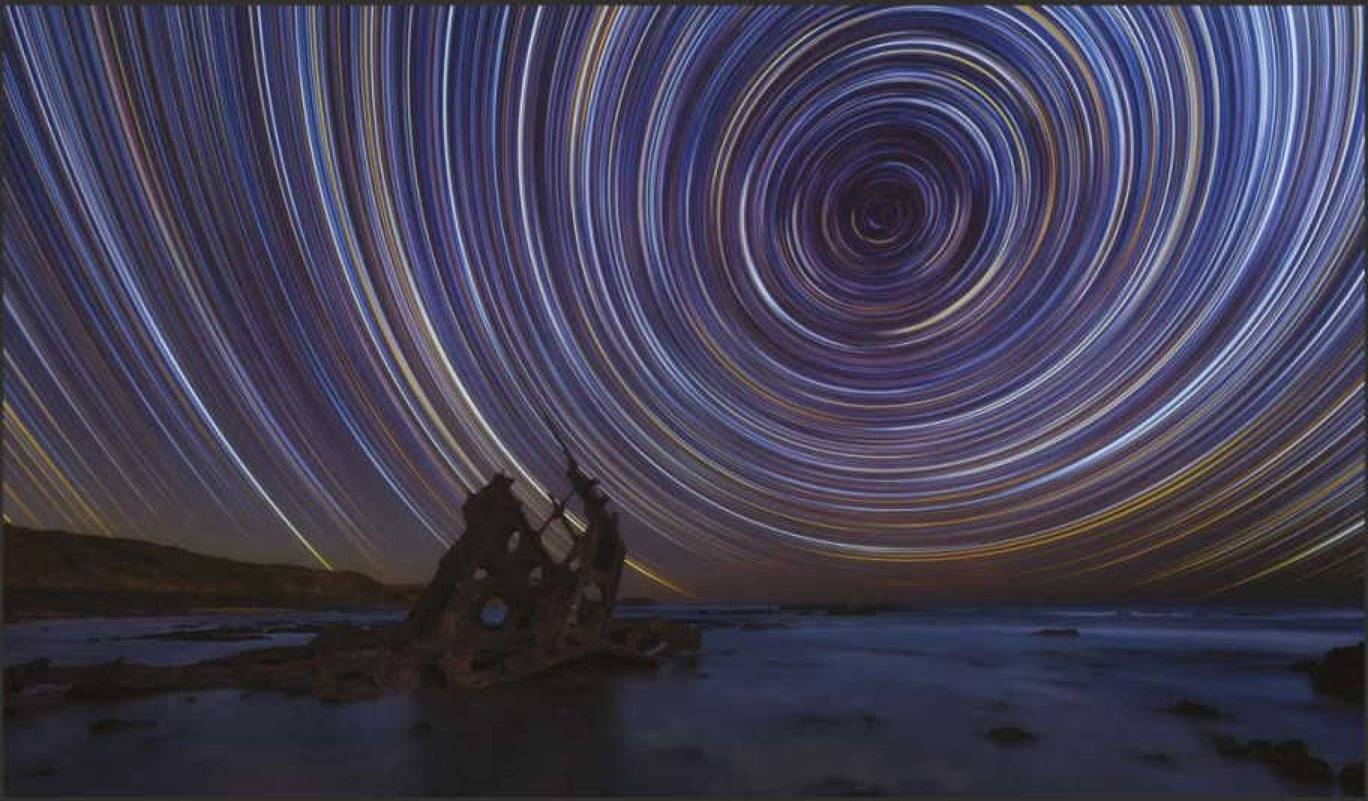
Equipment: Nikon D810 DSLR camera, 15mm f/3.2 lens

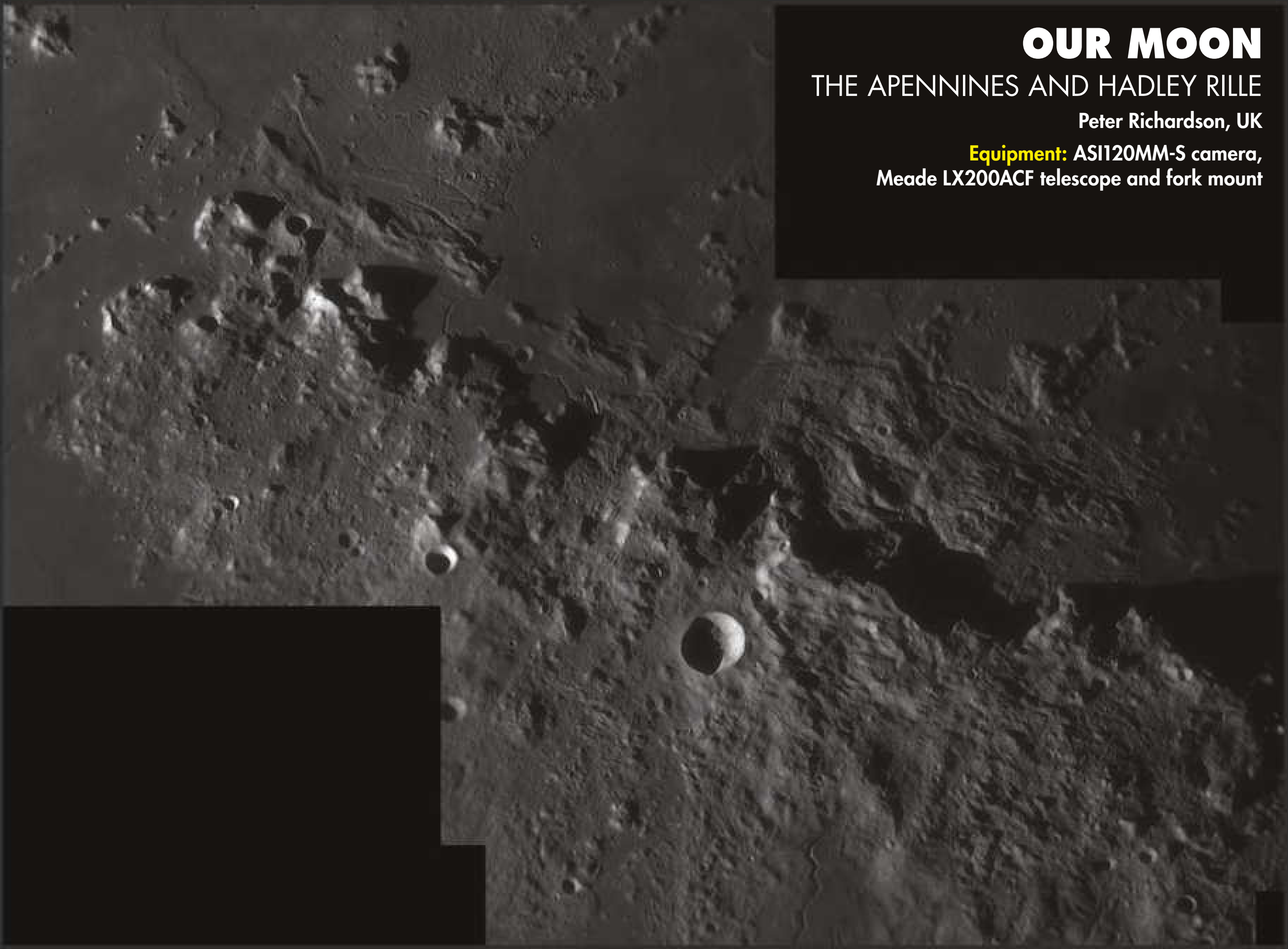
▼ SKYSCAPES SPONSORED BY INSIGHT INVESTMENT

S.S. SPECKE

Lincoln Harrison, Australia

Equipment: Nikon D810 DSLR camera, Nikkor 14mm f/2.8 lens





OUR MOON

THE APENNINES AND HADLEY RILLE

Peter Richardson, UK

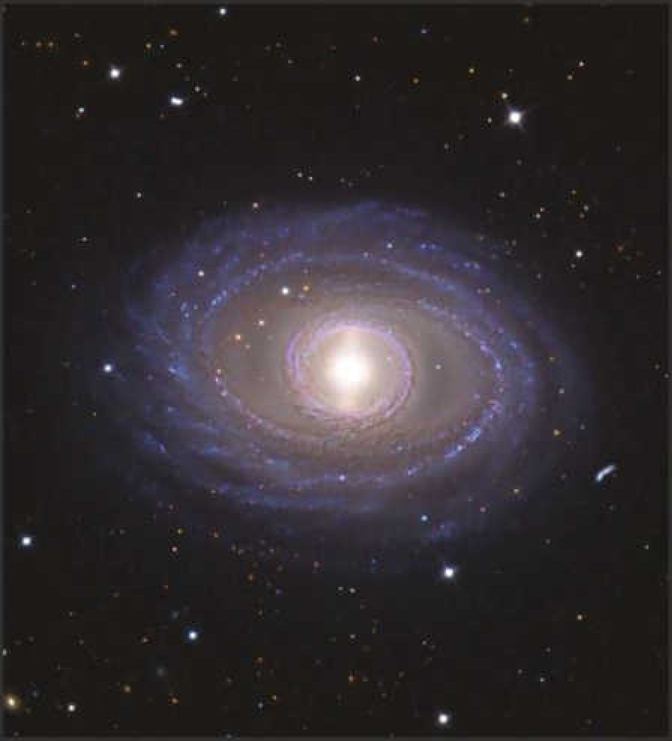
Equipment: ASI120MM-S camera, Meade LX200ACF telescope and fork mount

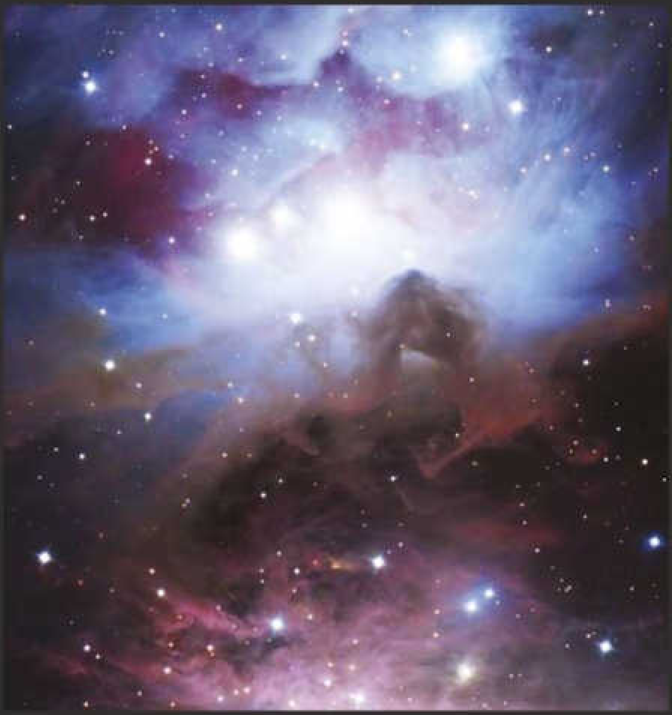
▼ GALAXIES

WHEEL IN THE SKY (KEEPS ON TURNIN')

Adam Block, USA

Equipment: SBIG STX16803 camera, 0.8m (314in) Schulman telescope





▲ ROBOTIC SCOPE

BRIGHT AND DARK NEBULAE IN NGC 1977 REGION

László Francsics, Hungary

Equipment: FLI PLO09000 camera, corrected Dall-Kirkham telescope, Planewave Alt-Az mount

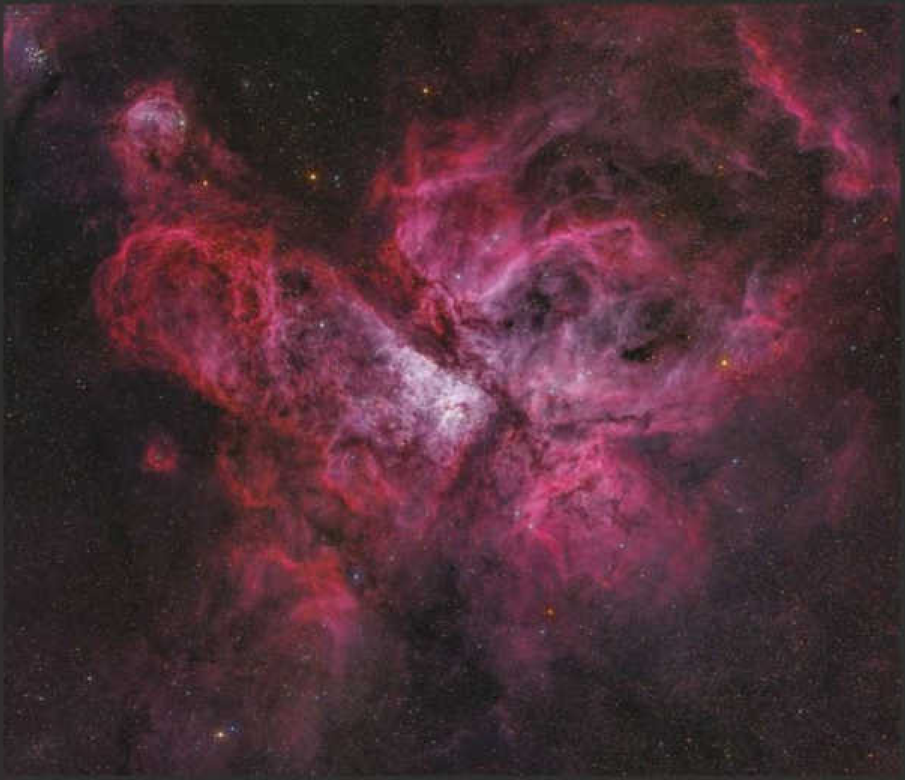
INSIGHT
ASTRONOMY
PHOTOGRAPHER
OF THE YEAR

STARS & NEBULAE ▶

GREAT CARINA NEBULA

Peter Ward, Australia

Equipment: SBIG STX16803 camera, AP Honders Astrograph telescope, Paramount PME mount

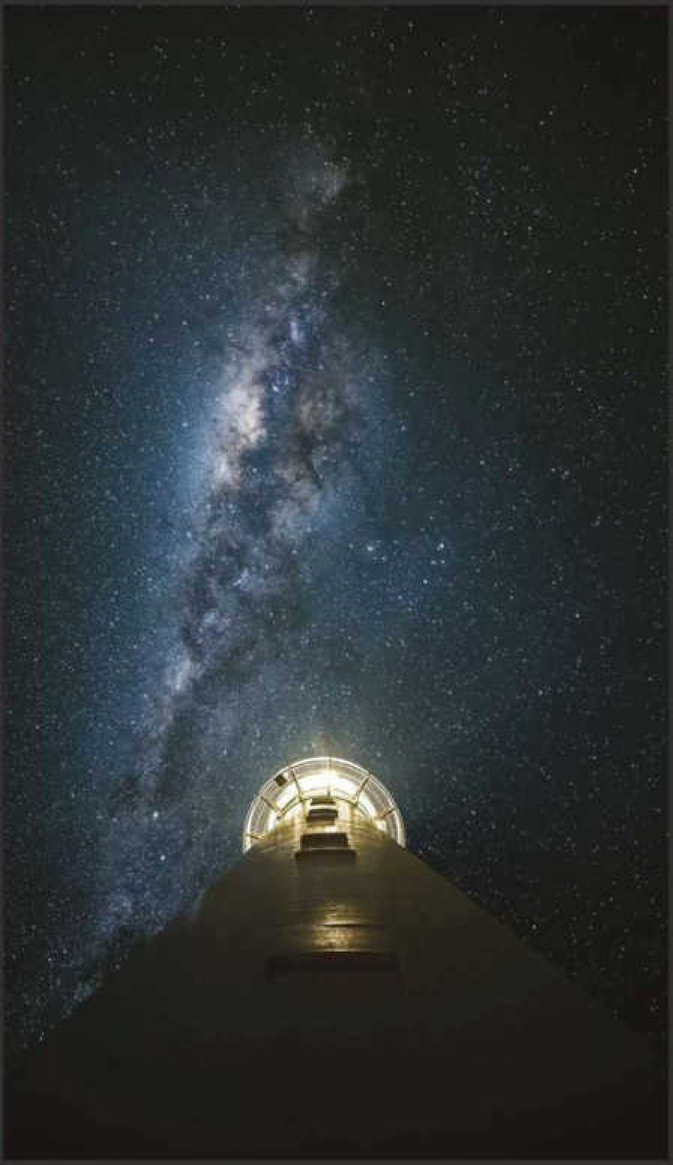


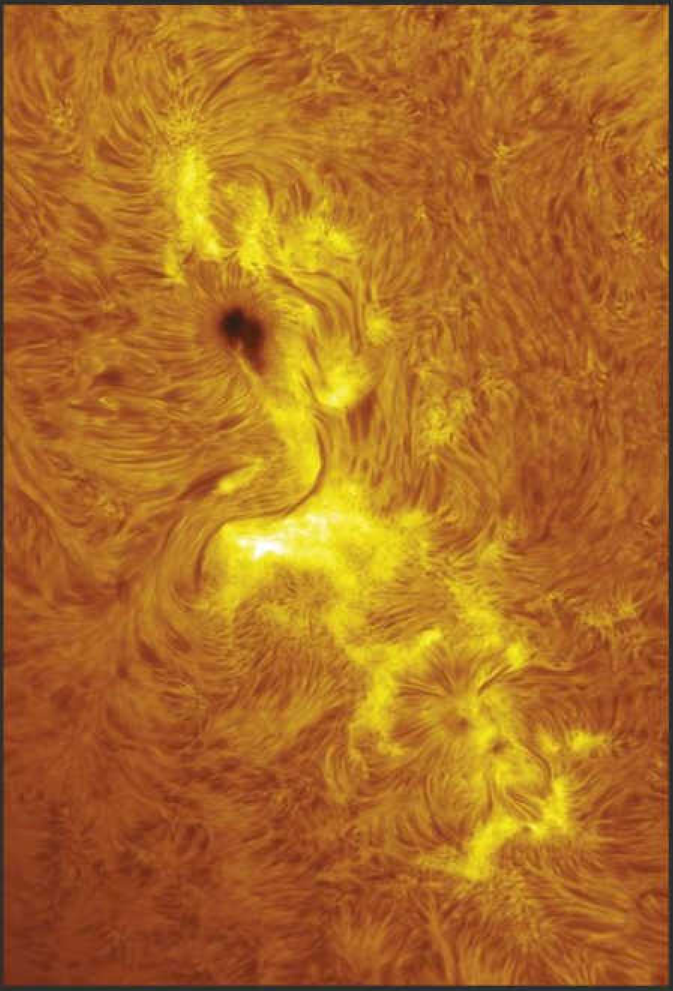
▼ SIR PATRICK MOORE PRIZE FOR BEST NEWCOMER

MEET THE STARS

Arun Mathew, India

Equipment: Canon EOS 5D Mk III DSLR camera, 14mm lens



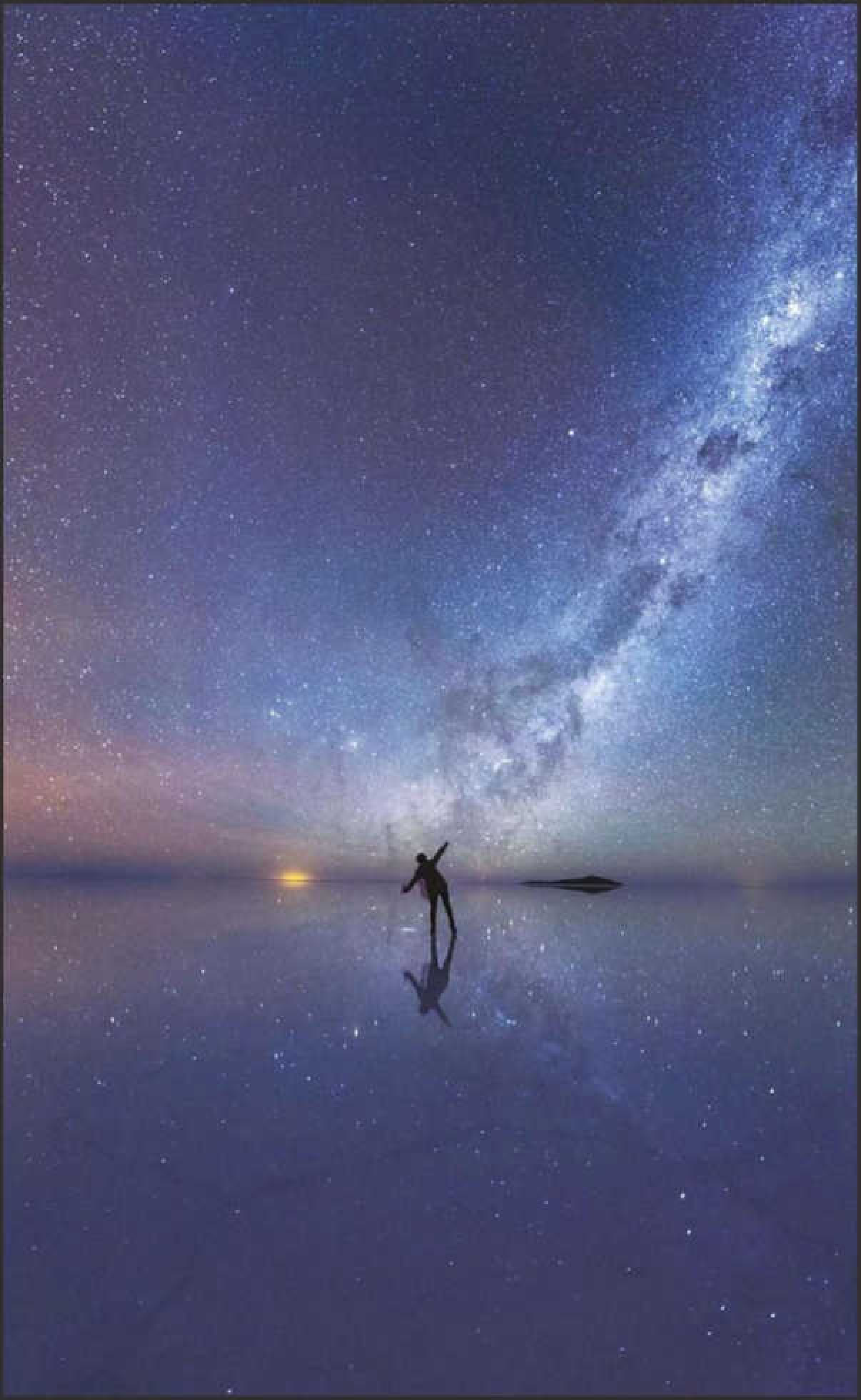


▲ OUR SUN

H-ALPHA SUNSPOT

Eric Toops, USA

Equipment: Point Grey video camera, home-made H-alpha telescope

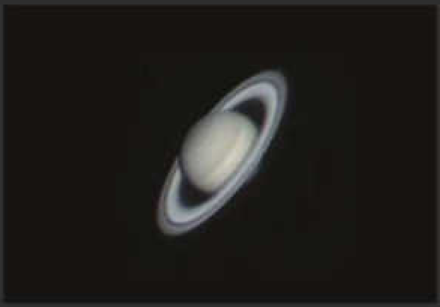


◀ PEOPLE & SPACE

THE MIRRORED NIGHT SKY

Xiaohua Zhao, China

Equipment: Canon EOS 5D Mk III DSLR camera, f/2.8 lens



▲ YOUNG ASTRONOMY PHOTOGRAPHER OF THE YEAR

THE GREAT LORD OF THE RINGS

Gabriel Tavares, Brazil – aged 15

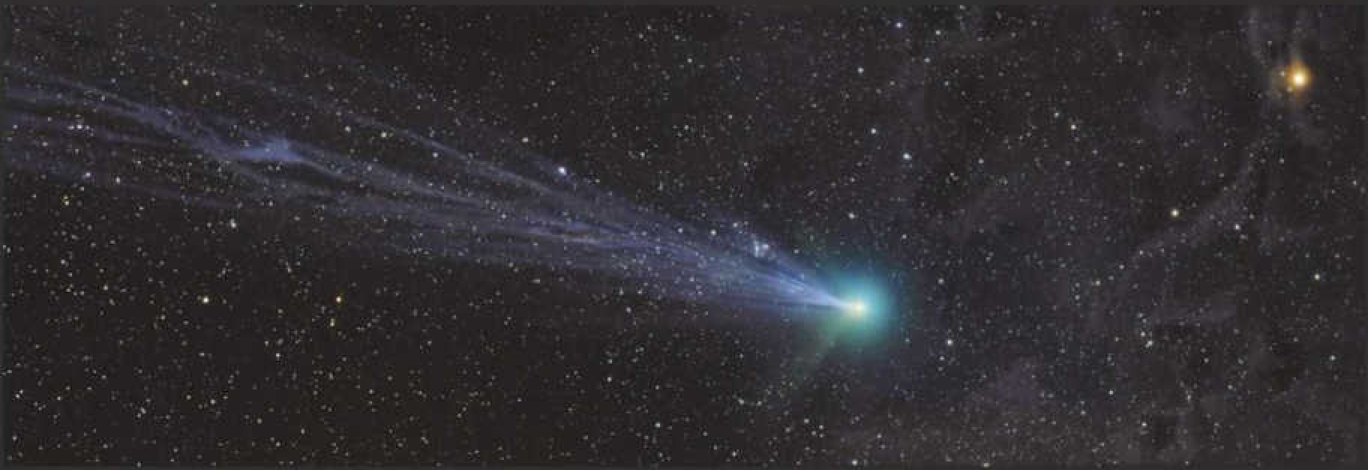
Equipment: ASI120MC camera, 150mm Newtonian telescope, EQ3-2 equatorial mount

▼ PLANETS, COMETS & ASTEROIDS

C/2014 Q2 LOVEJOY

Lefteris Velissaratos, Greece

Equipment: SBIG STL 11000M camera, FSQ106 f/5 telescope, EQ8 mount



A STUDY IN TIME: LUNAR CRATERS

Pete Lawrence shows you how to shoot images of lunar craters, then combine the photographs for a striking display

The Moon's ever changing phases and the dramatic shadows that are cast across its airless surface can be quite astonishing. The boundary line between lunar day and night is known as the lunar terminator. When a feature is in the bright portion of the Moon's disc and the terminator is close by, it means that the Sun is low in the lunar sky for that feature.

Point a torch at a flat painted wall and it'll look, well, flat. However, if you put the torch right up against the wall and aim its light along the plane of the wall, all manner of lumps, bumps and imperfections become apparent because of the shadows they cast. The same thing happens when the terminator's close to a lunar feature.

In addition, the Moon's tilt has a small degree of variability in it. This causes features close to the lunar limb to move closer and further from the Moon's edge over time; an effect known as libration. This too, helps change the appearance of features as we sometimes see them from above and sometimes more from the side.

This project will attempt to capture all this amazing lunar changeability by creating a feature calendar. The idea is simple – pick one feature on the Moon's disc and image it over as many nights as you can throughout the year.

RECOMMENDED EQUIPMENT

Telescope

Camera/camera adapter

IR-pass or red filter for mono high frame rate cameras

Driven equatorial mount

Shadow-play

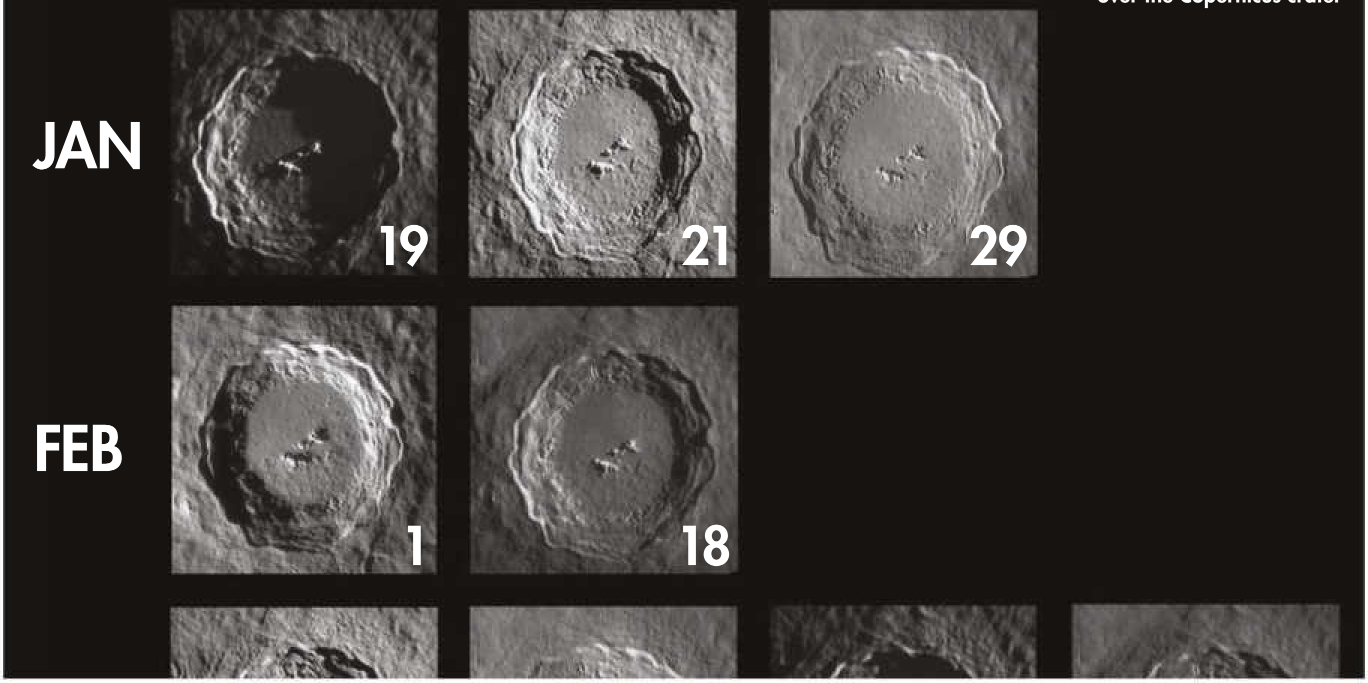
The period from one phase, through a complete cycle of phases back to the starting phase, is known as the Moon's synodic period and is equal to 29.5 days. Of this period, any feature will be hidden from view for half of it while it experiences lunar night. The timing for its reappearance from, or disappearance into, the lunar night won't always be optimal for your location.

Coupled with the vagaries of the weather, the number of days each cycle you'll be able to image your chosen feature will probably be fairly small. However, imaging over the course of a full year should give you enough frames to put together a stunning end result which shows just how dramatic shadow-play on the Moon can actually be.

The project isn't too demanding on equipment type and will work with low or high image scale (magnification) setups. It'll work best if the same setup is used throughout. Closer views will provide more 'personal' changes to a particular feature. A stills camera can be used, but the best results will come from a high frame rate planetary camera.

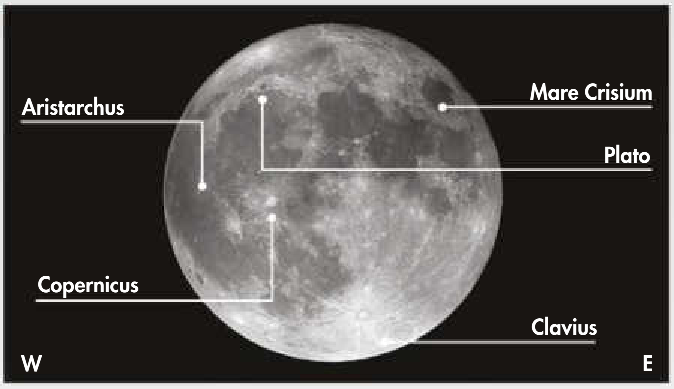
COPERNICUS 2016

Images recorded as the phases of the moon rotate over the Copernicus crater



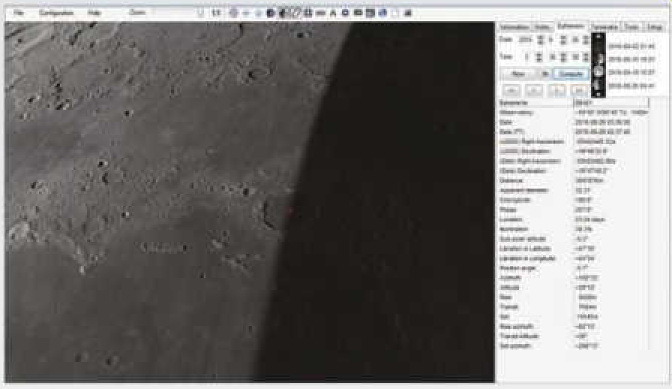
PETE LAWRENCE X 7

STEP-BY-STEP GUIDE Choose your crater and combine your images



STEP 1

Choose what you want to follow. Features close to the eastern limb are good during spring evenings. Those closer to the western limb are best in autumn but require early morning sessions. Central features are a good compromise. Our recommendation would be Mare Crisium, Clavius, Plato, Copernicus or Aristarchus. Or even better, all of them!

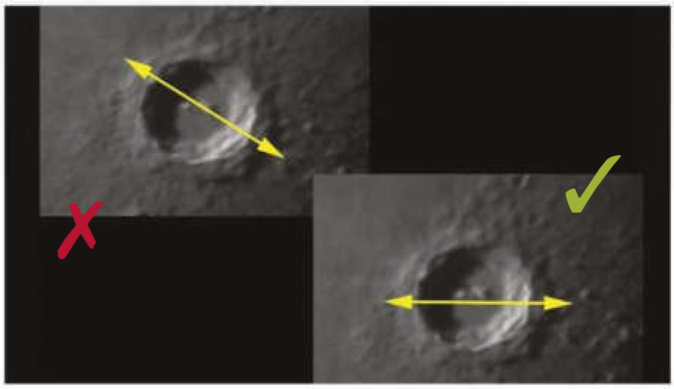


STEP 2

It helps to have a good lunar planner to check out when the feature(s) you have chosen will be on view. The Virtual Moon Atlas (http://ap-i.net/avl/en/start) is highly recommended. This will show the Moon's phase, terminator position, feature location and the moonrise and set times from your location.

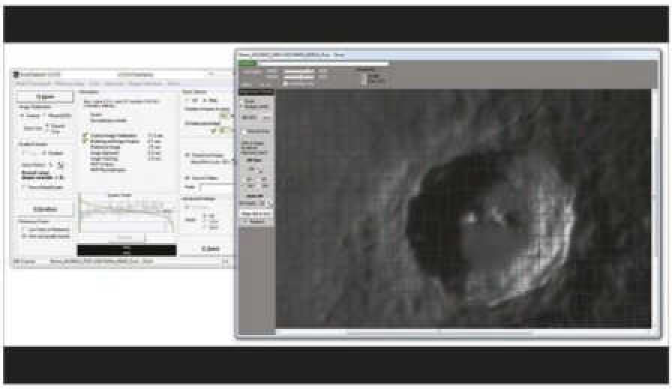
STEP 3

The best imaging results will come from using a mono high frame rate camera fitted with either a red or infra red pass filter. The latter only works if your camera doesn't already have an IR-blocker fitted. These filters help stabilise the wobbles caused by atmospheric seeing and can provide sharper end results.



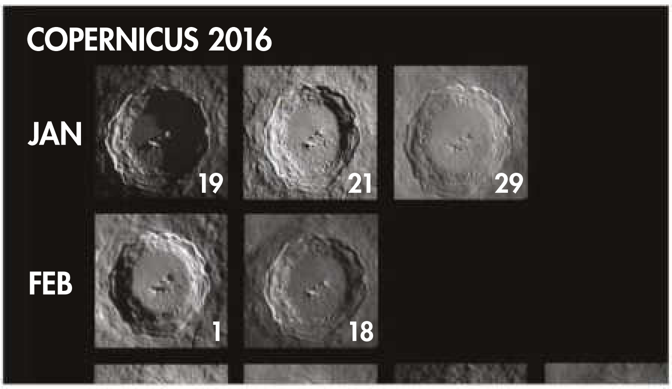
STEP 4

Slew your scope slowly back and forth in RA, rotating the camera until features move parallel to the frame's bottom edge. Lock the camera in position and focus accurately. Adjust the gain/exposure to give a bright but not saturated result. Keep the gain low. Centre your feature and capture 500-1000 frames as an AVI.



STEP 5

Register and stack the AVI. As an example, using the freeware program AutoStakkert, drag the AVI onto the main program window. Select 'Surface'. Ctrl-click on a high contrast region in the preview window. Tick 'sharpened images'. Click 'Analyse'. When done, select AP size (100 is a good start) and 'Place APs in grid'. Finally, click 'Stack'.



STEP 6

Open the sharpened result (normally found in a folder within the AVI's folder) in an image-editing program and tweak as required. Insert it into a large results canvas, and date the image. Align others in the canvas as you take them. Use one row for a month's worth of images to keep the sequence more coherent.

A PORTRAIT OF THE SOLAR SYSTEM

Pete Lawrence creates a striking composite image of Solar System objects using photographs captured throughout the year

RECOMMENDED EQUIPMENT

- **Camera of any type**
- **Telescope on driven equatorial drive (not essential**
- **DSLR with a 300-400mm lens for the outer planets and comet shots**

The Solar System is a dynamic place. Unlike the stars and deep sky objects, planets and the odd comet move and change over short timescales, and this makes them special. So why not celebrate the Solar System by creating a gallery of its main occupants.

You can do this any way you like according to your skill and experience. A basic camera can take shots which show the planets as dots in the sky. A telescope helps you get a closer view, but here too it's possible to use quite basic equipment. Holding a phone or camera up to the pre-focused eyepiece of a telescope pointed at the Moon can get a great shot of the lunar surface, a technique called afocal imaging.

Afocal targets

Fit your telescope with a solar safety filter (not forgetting to cap the finder) and afocal imaging can be used for a shot of the Sun too. Venus is another candidate, and if you become adept Mercury, Mars, Jupiter and Saturn can be grabbed afocally too. The outer planets may be a bit more challenging, but it's always worth giving them a try.

If you have a DSLR then the outer planets, Uranus and Neptune, shouldn't be too much of a challenge and can be snapped as dots in their respective star fields.

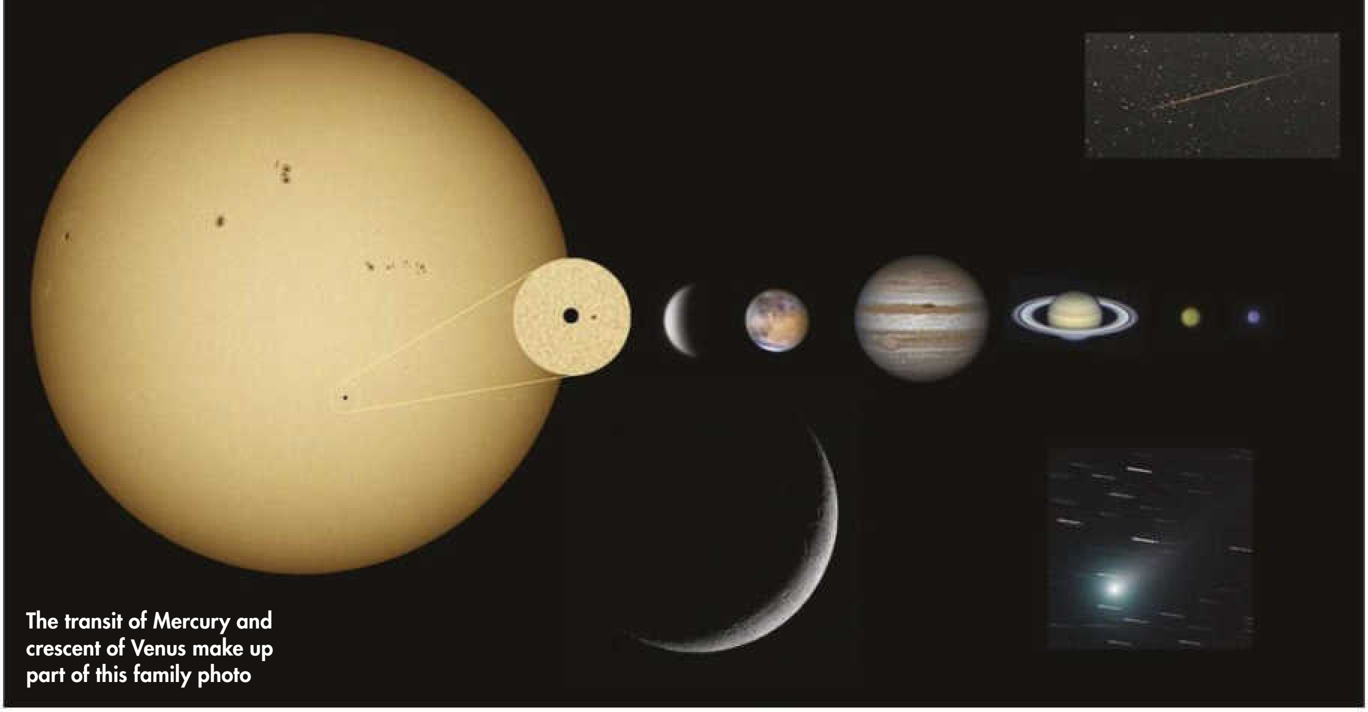
This offers up another opportunity too, because the dwarf planets Ceres and Pluto, along with the brighter minor planets, can be captured with a telephoto lens on a DSLR. A focal length of 300-400mm is recommended for this. If you're set up for high frame rate planetary imaging, this too can cover most bases but you'll need a camera with long-exposure capability to capture objects like Pluto.

That's quite a target list to aim for, but it doesn't end with the planets. The larger moons of Jupiter and Saturn are very viable targets as well. Those who can get in close to Mars and extend the exposure may also manage an image of its two tiny moons, Phobos and Deimos, when the planet comes to opposition on 22 May. Uranus and Neptune all have moons which can be imaged by amateurs too.

Comets can also be included in the family portrait. C/2013 US10 Catalina is definitely a candidate here, especially as it's well positioned from the UK at the start of the year.

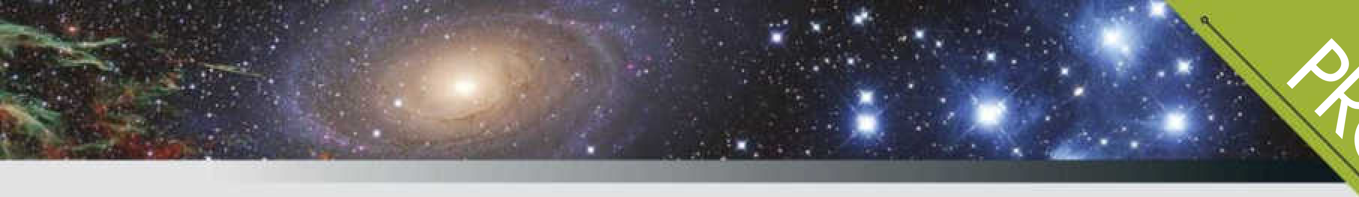
Finally, the elusive planet Mercury puts on a real show on 9 May when it transits the Sun's disc. What better shot of it could you ask for to act as a centrepiece for your Solar System portrait?

SOLAR SYSTEM OBJECTS PHOTOGRAPHED IN 2016



The transit of Mercury and crescent of Venus make up part of this family photo

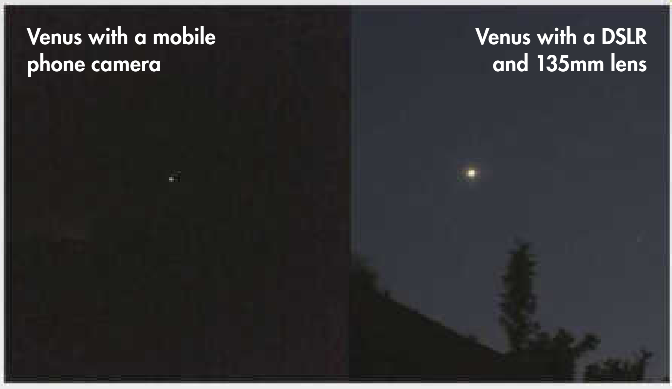
PETE LAWRENCE X 7



STEP-BY-STEP GUIDE Capture a Solar System family portrait

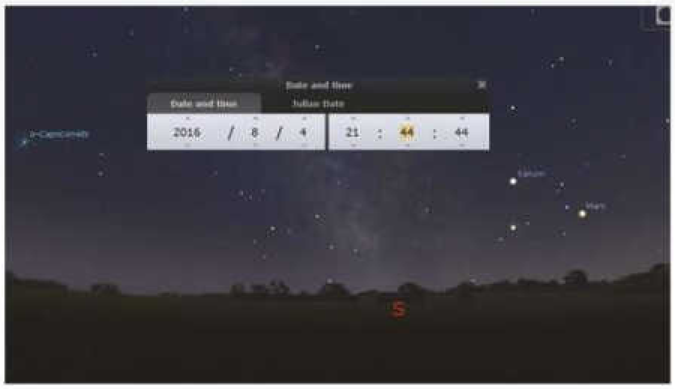
STEP 1

For solar shots, a protective filter should be used. Building your own out of Baader Astrosolar film is an inexpensive way to achieve this (see www.skyatnightmagazine.com/feature/how-guide/how-observe-sun-safely). A stills camera can take a decent shot of the Sun. Ensure that the image is not over-exposed and doesn't contain any pure white.


Venus with a mobile phone camera
Venus with a DSLR and 135mm lens

STEP 2

The brighter planets, Venus, Mars at opposition and Jupiter, can be imaged as dots using a basic camera. A DSLR will record Mercury, Saturn, Uranus and Neptune as well as fainter objects such as Pluto, Ceres and minor planets. A fixed tripod is fine, but observe the rule that exposures should be less than (500/lens focal length) seconds to avoid trailing.

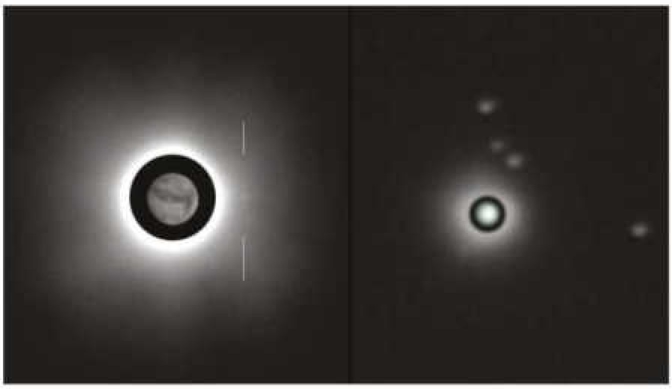


STEP 3

It pays to plan ahead to capture as many objects as you can. A freeware planetarium program such as Stellarium (www.stellarium.org/en_GB) or Cartes du Ciel (www.ap-i.net/skychart/en/start) is a great help, as are the many astronomy apps available for mobile devices.

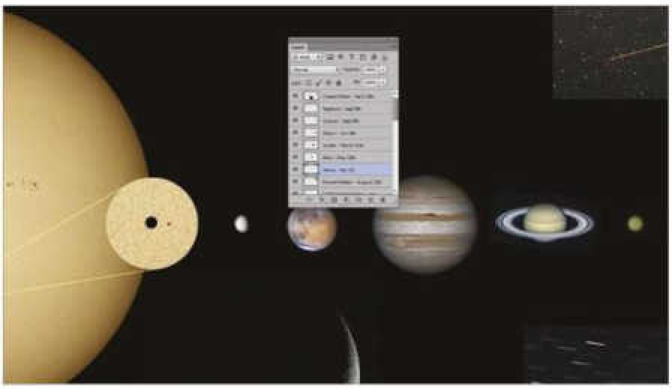
STEP 4

A DSLR with a telephoto lens is an idea way to record comet C/2013 US10 Catalina. For fixed tripod setups, raise the ISO to 1600 or 3200, pre-focus at infinity (use Live View on a bright star or planet) and fully open the lens (lowest f/number). Expose for (500/lens focal length) seconds.



STEP 5

High frame rate setups are ideal for imaging the planets as discs. Extending exposures on an equatorially mounted setup may capture moons of Neptune and Uranus. Large scopes and image scales may even catch the moons of Mars around opposition. Expose so the disc is just over-exposing and examine the region close to the planet's limb.



STEP 6

As you catch your images, use a layer based editor such as GIMP (www.gimp.org) or Photoshop, adding each shot as a separate layer. In this way, if you manage to obtain a better shot than the one currently in place, you can easily replace it without too much bother. See how many different Solar System members you can catch.

A YEAR LONG TIMELAPSE

Pete Lawrence shows you how to shoot a series of images that record star movements over an entire year, and make a movie

A timelapse of the stars moving relative to the horizon can be a very beautiful thing and it's not too hard to do. Point a camera at the sky, preferably with a subtly lit foreground horizon, set the sensitivity so that the stars record and keep taking exposures at regular intervals, say one to five minutes apart, for as long as you want your animated timelapse to continue.

So, how about taking a timelapse that covers a complete year? Sounds crazy, but with a bit of planning it is quite possible, even with the UK's unpredictable weather.

RECOMMENDED EQUIPMENT

- **DSLR camera**
- **Wide-angle lens, 18mm focal length or shorter**
- **Atomic accuracy time-piece**
- **Tripod**
- **Remote shutter release**

The basic idea is quite simple. Set a camera up and take an exposure at the same time of night throughout the course of a year. Immediately, there's an issue, because in order for this to work, you need to set the time for the shot to coincide with the darkest part of the night. If you don't, the short nights around the June solstice will catch you out.

Location is important too. In order to work properly, you need to site the camera to give a good view in your preferred direction. Obviously, this is dictated by your own circumstances. A deciduous tree appearing at one side of the frame or perhaps a flowering shrub at the bottom could work wonders here too. Just make sure they aren't going to grow so much that they obliterate the view!

Light work

A light can be used to illuminate foreground objects but will need to be used consistently to maintain similarity between light levels and avoid flickering when animated. As you'll need the same exposure location each time you set up, it's also useful to choose somewhere which will be available throughout the year!

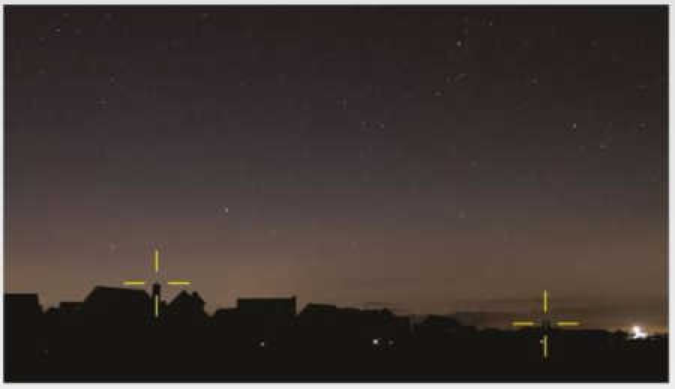
Unless something miraculous happens, the weather will be a problem. However, there's a clever trick you can employ to cover yourself for short periods of cloud cover. When you take a shot of the night sky from the same location at precisely the same time, the stars will move by approximately one degree to the west each day. So if you take a shot on one night and repeat it the next night at the same time, flicking between both images will show the stars moving by this small amount.

However, the stars move by the same amount every four minutes. So if bad weather or holidays interrupt your daily sequence, you can fill the gaps by taking a batch of shots on the same night at four-minute intervals before or after your main shooting time. It's cheating slightly, but it will allow you to create a smooth sequence.

Seen at the same time, the stars move by about a degree each night

PETE LAWRENCE X 7, ISTOCK

STEP-BY-STEP GUIDE Take a photo every night, then combine them



STEP 1

Decide on location. A north view gives lovely arcing star trails or, better still, complete circles with a wide enough lens. Facing north also reduces effects from the Moon. Mark your tripod's position so it can be repeated each night. It's important to have two fixed horizon features, visible all year round, in shot for accurate alignment.

STEP 2

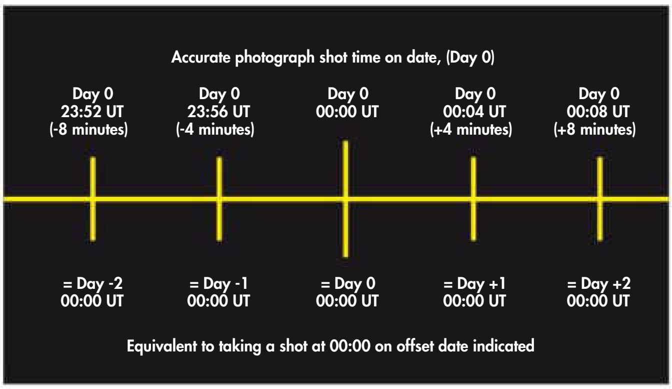
A fixed tripod makes a good platform. A camera lens of 18mm focal length or shorter is recommended to include a decent amount of sky in the shots. For added drama, place a deciduous tree or flowering shrub at the edge of frame. Your mega-timelapse will show how these change throughout the year too.

STEP 3

If required, use a light to illuminate any foreground objects. Be aware that you'll need to replicate the light's position and intensity between shots. Set the lens to manual focus (MF) and accurately focus on a bright star. Set the f/number of the lens to around f/8-11 to give a good depth of field.

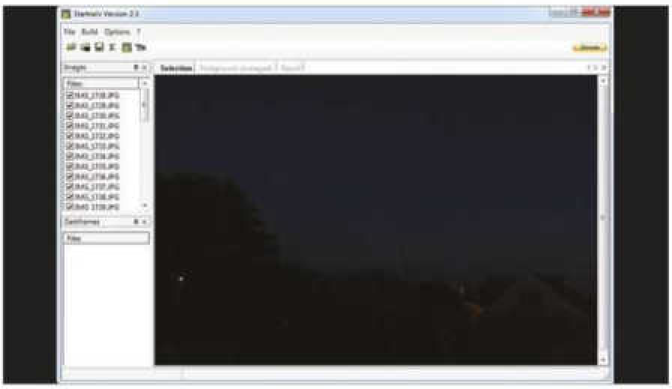
STEP 4

Set ISO to 800 or 1600. Use the 500/focal length = longest exposure time rule to avoid star trails. Repeat settings for all shots. The best target time is 00:00 UT accurately repeated using an atomic clock source (e.g. www.timeanddate.com/time/international-atomic-time.html). Use a remote shutter release or the camera's self timer to avoid camera shake.


Accurate photograph shot time on date, (Day 0)
Day 0 23:52 UT (-8 minutes)
Day 0 23:56 UT (-4 minutes)
Day 0 00:00 UT
Day 0 00:04 UT (+4 minutes)
Day 0 00:08 UT (+8 minutes)
= Day -2 00:00 UT
= Day -1 00:00 UT
= Day 0 00:00 UT
= Day +1 00:00 UT
= Day +2 00:00 UT
Equivalent to taking a shot at 00:00 on offset date indicated

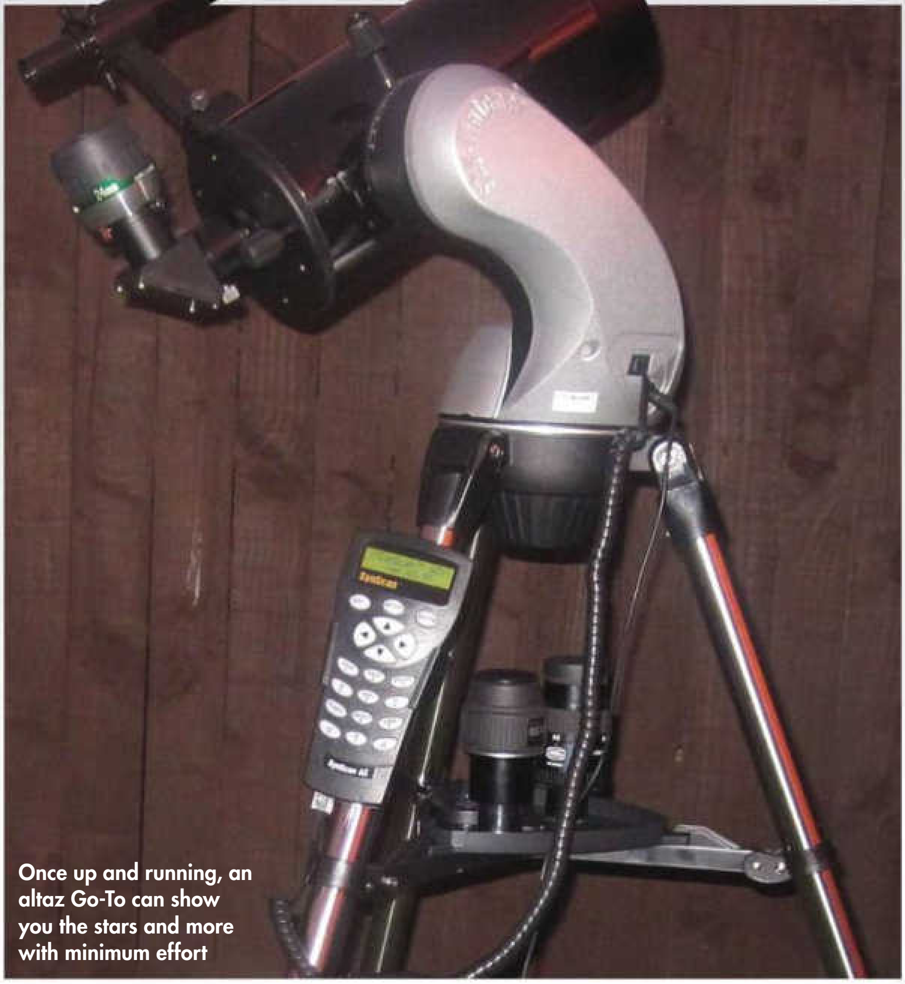
STEP 5

Taking images at four-minute intervals either side of the target time simulates shots from previous or subsequent nights. Once taken, load your shots as separate layers in a layer-based editor and adjust their position so that the fixed horizon references are aligned. Save these aligned results and keep them safe, ready for the final step.



STEP 6

When you have all 365 aligned shots, packages such as Star Trails (www.startrails.de/html/software.html) or Windows Live Movie Maker (http://windows.microsoft.com/en-gb/windows-live/movie-maker) can be used to turn them into a final movie. These are simple to use and will output your still images as a dramatic time-lapse of the whole year.


Once up and running, an altaz Go-To can show you the stars and more with minimum effort

TOOLS AND MATERIALS

COMPASS AND INCLINOMETER
If you can't see Polaris, use a good compass and an inclinometer to find the celestial pole. Your local latitude is the celestial pole's altitude.

SPIRIT LEVEL
This is useful for levelling the tripod if it doesn't have one already built in. Some mounts also need the scope to be levelled prior to alignment.

POWER SUPPLY
A rechargeable 12V battery is a much more reliable alternative to alkaline batteries.

STAR CHART
Use your preferred star chart or planisphere to find suitable alignment stars.

EYEPIECES
You will need low- and high-power (at least 100x) eyepieces to centre your alignment stars, and a medium-power eyepiece to confirm that alignment is successful.

How to... SET UP AN ALTAZ GO-TO MOUNT

Andrew Phethean shows you how to get your altaz telescope up and running

Altaz Go-To mounts are a handy option for busy astronomers as they enable you to slew your scope to thousands of celestial objects at the touch of a button. To make the most of this convenience, however, these mounts need to be set up carefully and methodically. This guide will help you get your routine down to a tee so you can get out observing quickly and with the minimum of effort. For the purposes of this article, we're using a Sky-Watcher Skymax-127 loaned to us by The Widescreen Centre.

The first thing is to choose a site for your telescope. There are several factors you might want to consider when making this decision: low horizons (particularly to the south), lack of direct light pollution, firm ground and shelter from the wind are all advantages worth keeping in mind. Once you have settled on a location, use a compass to work out which direction is north and determine your local longitude and latitude – you can find this information online at www.latlong.net.

Place your tripod on the ground and make it as stable as possible. Set the tripod's height carefully as you will lose alignment if you have to alter it later on, adjusting each leg individually to make sure it is level. Many tripods are fitted with spirit levels to help you to do this; if yours doesn't have one, rest an external spirit level on the accessory tray.

Firm foundations

To save time in the future, you can mark the ground where the tripod legs stand. For a grass surface, brightly coloured plastic golf tees make good temporary markers, or for a longer-term marker you could cut out the turf and put in a small paving slab. On hard surfaces you could apply a spot of paint or even drill a small depression into which the tripod feet can settle. It's a good idea to have one leg pointing north – this will be useful if you decide to upgrade to an equatorial mount at some point in the future. Another time-saving trick for setting height and levelling is to mark the position of the lower sections

ALL PICTURES: ANDREW PHETHEAN

of the tripod legs with a marker pen or some stickers.

Mount alignment routines vary between manufacturers, so read the instructions carefully for your particular mount. On some mounts you need to orientate the scope horizontally or point it towards the celestial pole (aim at Polaris) before you switch it on. If the mount is fitted with setting circles, you can use these, but they might not be very accurate. To avoid mechanical sag affecting the accuracy, make sure all thumbscrews are tightened properly.

Data is critical

Once you've switched on the mount, you will need to input the latitude, longitude, date and time. Take care to enter these correctly; note that on many mounts the date format is MM/DD/YYYY. Also be aware that you will need to activate daylight saving time when the clocks change in spring.

Check which alignment methods are available on your mount. Three-star alignment takes a little longer than two-star, but you will enjoy more accurate slewing. The farther apart the alignment stars, the more accurate the alignment will be, so choose stars at least 60° apart: one each in the east, west and (for three-star alignment) south.

Centre the first alignment star in your finderscope; you'll need to make sure the finder is well aligned to your telescope tube in advance. Once done, centre the star in a low-magnification eyepiece. Swap for a high-power one and do the same again, then confirm the position on the handset. Once the first alignment point has been established, the mount usually slews to the next chosen star.

When the last star has been centred and confirmed, you will hopefully see an 'alignment successful' message. If not, you will have to go through alignment again. Assuming it is successful, pick an object, preferably not too close to any of the alignment stars, and watch how accurately the mount slews: your new target should be within the field of view of a medium-power eyepiece. Some mounts have a feature called 'pointing accuracy enhancement', which can be used for fine tuning if your target is still a little off-centre.

STEP-BY-STEP GUIDE

Everything you need to know to start observing

STEP 1

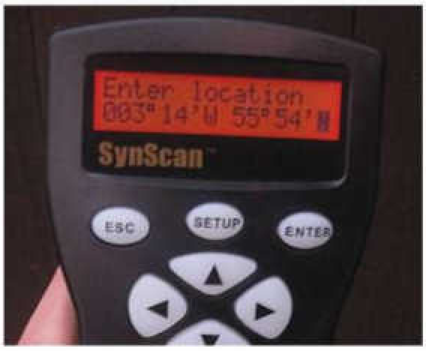
When you've chosen a suitable site for your telescope, get your bearings. Locate north and look up the local latitude and longitude to one arcminute. Prepare everything else you will need for your observing session, plus a spirit level, star chart and the mount's manual.

STEP 2

Place your tripod at the observing site with one leg facing north, then set the tripod height and level it. Make sure the ground is firm and that all the tripod fixings are tight. If you are going to use this site regularly, mark the tripod leg positions to for next time.

STEP 3

Attach your observing telescope to the mount, plug in the Go-To hand controller and connect the power supply. Consult your mount's manual to check if the scope needs to be pointed in a particular direction before you turn on the power.

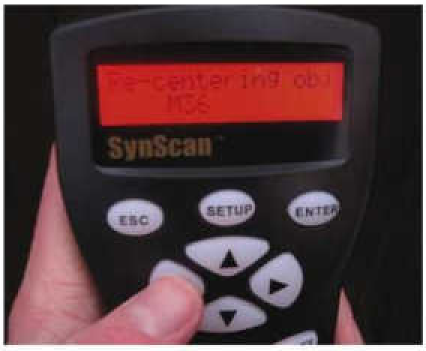


STEP 4

The mount will now prompt you to enter various details. Set the date, time, time zone and local coordinates. These need to be accurate so that the mount can correctly plot the planets and your local horizon. Press Enter to proceed to alignment.

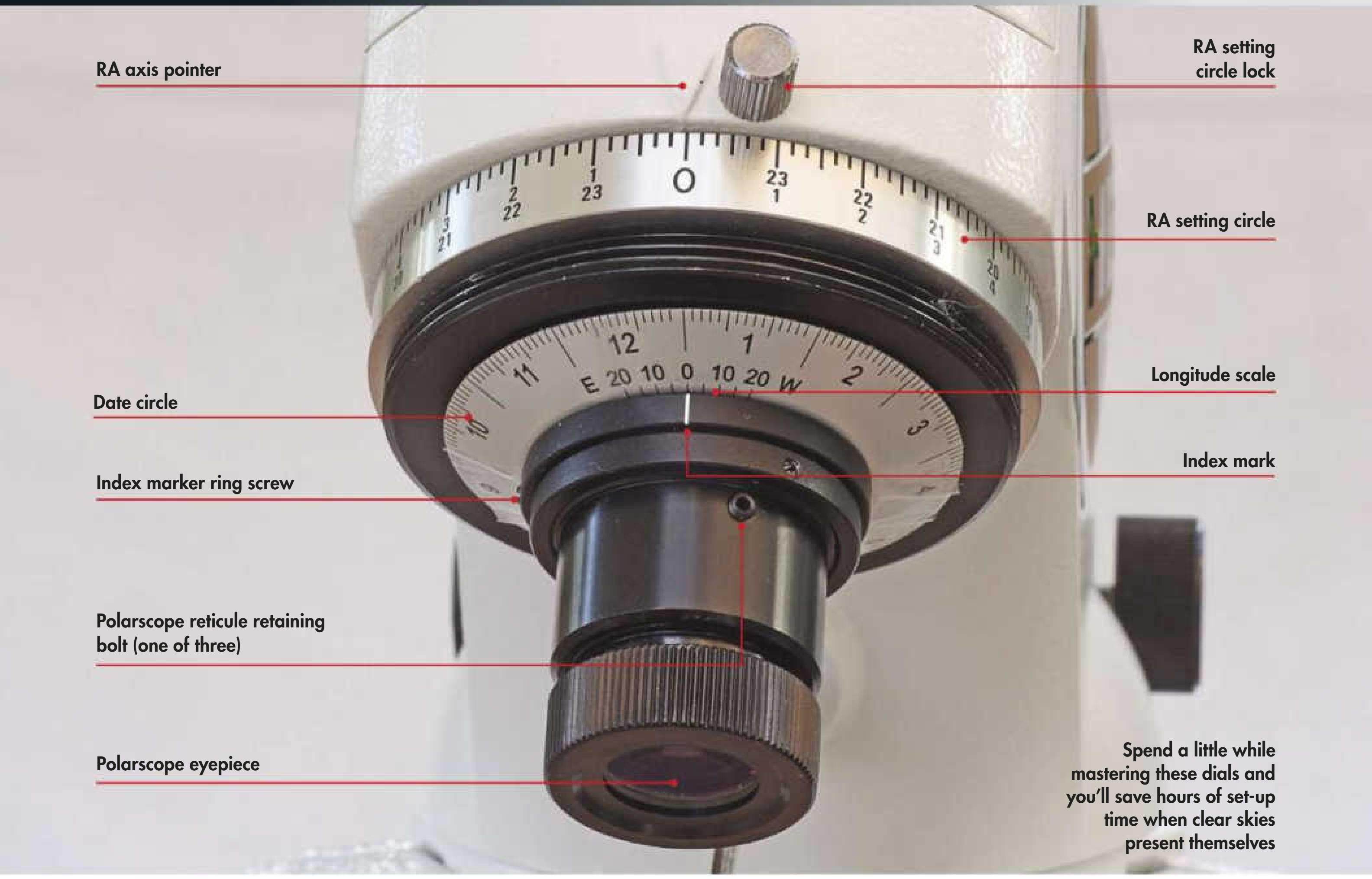
STEP 5

Pick your alignment method, then choose stars that are well separated from the celestial pole and from each other – use your star chart to identify candidates if you need to. Centre the stars in your finder, at low power and at high power, then confirm their positions.



STEP 6

When alignment is complete, slew to a new target and check that the mount centres it in a medium-power eyepiece. If your target is outside the field of view, repeat steps 5 and 6. 'Pointing accuracy enhancement' can be used for fine tuning, if your mount supports it.



Spend a little while mastering these dials and you'll save hours of set-up time when clear skies present themselves

How to...
REFINE YOUR POLAR ALIGNMENT

Steve Richards shows you how to get properly lined up on Polaris

Polar aligning your mount using the engravings of Cassiopeia and the Plough on your polarscope is fine for basic visual observing, but if you need more accuracy, here's an alternative technique. It uses the setting circles as a circular slide rule, allowing you to calculate the position of Polaris more precisely – useful if you want to take long-exposure images of deep-sky objects as any inaccuracy in your polar alignment will cause field rotation, resulting in stars trails around the centre of the image.

Your mount's setting circles need to be calibrated before you can use them. The first step is to ensure that your polarscope is correctly aligned within your mount's right ascension (RA) axis. Next, rotate the RA axis until the circle representing Polaris on the reticule is pointing vertically downwards, then lock it. As the view through the polarscope is inverted, in this position Polaris is shown in transit – in other words, directly above the north celestial pole. This gives us a known reference point. Set the first of two calibration points by unlocking the RA setting circle and rotating it until the engraved zero aligns with the pointer on the mount. You can find out dates and times that Polaris will be in transit using planetarium software.

If you're using a typical mount that isn't an NEQ6, rotate the date circle until the date of the transit lines up with the time of the transit in the top row of numbers in the RA setting circle. Set the second of the two calibration points by loosening the set screw on the index marker ring, and then rotating it until the pointer lines up with zero on the longitude scale engraved on the date circle. Tighten the set screw and your mount will be calibrated for later use from your location.

You can accurately polar align the mount in the future with a different approach. Set the RA setting circle to zero and tighten up the locking screw. Unlock the RA axis and rotate it until the current date on the date circle is aligned with the current time on the top row of numbers on the RA circle. Lock the RA axis. Viewing through the polarscope, adjust the altitude and azimuth bolts until Polaris appears in the centre of the Polaris circle engraved on the reticule.

Alternative approach

The process is slightly different if you're using an NEQ6 mount. Rotate the RA axis until the RA setting circle indicates the

ALL PICTURES: STEVE RICHARDS

TOOLS AND MATERIALS

ALLEN KEY
You'll need a 1.5mm Allen key to make the tiny adjustments needed to calibrate the reticule.

COMPASS
A magnetic compass will help you to set up your mount so that it's pointing in approximately the right direction.

JEWELLER'S SCREWDRIVER
A tiny, flat-bladed screwdriver will be essential to adjust the index marker ring.

KNEELING PAD
Carrying out the calibration routine can get uncomfortable as you need to get down low behind the mount – a kneeling pad will help enormously.

RED LIGHT TORCH
If your mount is not equipped with an illuminated polarscope reticule, you could use a red light torch to illuminate it from an oblique angle.

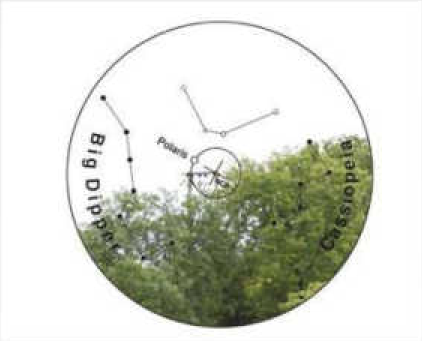
time of the transit on the bottom row of numbers. Lock the RA axis, and then rotate the date circle so that the pointer lines up with the date of the transit. Unlock the RA axis and rotate it until the RA setting circle points to zero and re-lock it. Finally, loosen the set screw on the index marker ring and set it to zero on the longitude scale. Gently tighten the set screw and your mount will be calibrated for later use from your location.

Achieving polar alignment at a later date is also different to the method for non-NEQ6 mounts. Rotate the RA axis until the pointer at the lower end of the mount aligns with the current date on the date circle and lock the RA axis. Loosen the RA setting circle and adjust it so the pointer aligns with the current time on the lower set of numbers and lock it in place. Rotate the RA axis so that the pointer points to zero and lock it in place. While viewing through the polarscope, adjust the altitude and azimuth bolts until Polaris appears in the centre of the Polaris circle engraved on the reticule.

FIND OUT MORE
Watch a polar alignment demonstration on our website at **http://bit.ly/align-refine**

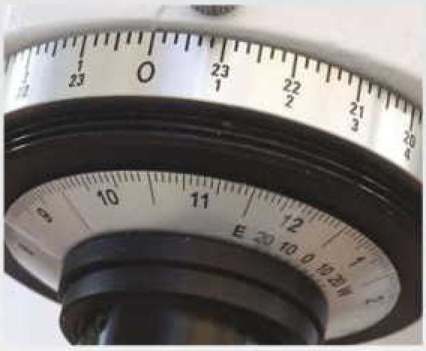
STEP-BY-STEP GUIDE

All you need to make sure your scope points north



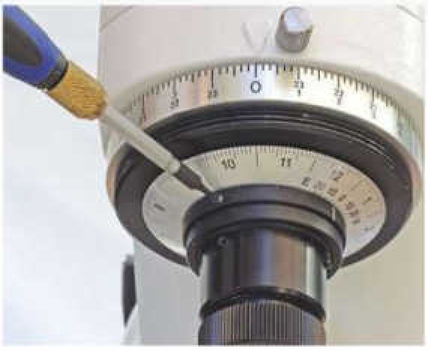
STEP 1

Calibrate the polarscope's reticule to ensure that it's accurately centred in the RA axis by aligning its crosshair on a distant object and rotating the RA axis to check for movement. Adjust the reticule until there's no crosshair movement when the RA axis is rotated.



STEP 2

Rotate the mount's setting circles so that they show the correct date and time for when Polaris is in transit. The time for this changes from day to day, but you can use a program such as Polarfinder (www.polarfinder.com) to help you find the transit time for any date.



STEP 3

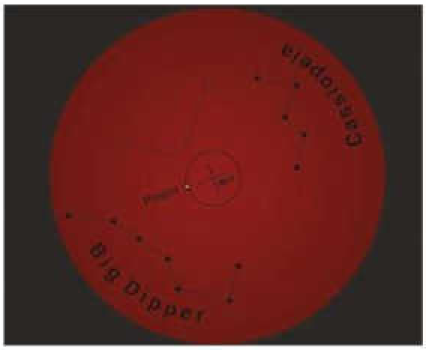
Calibrate the polarscope's index marker for your location by lining it up with the zero on the date scale. This procedure allows you to use the setting circles to calculate the position of Polaris in relation to the north celestial pole at any time in the future.

STEP 4

Set up your mount so that it's reasonably level and, using a magnetic compass, make sure the RA axis is pointing northwards. Use the altitude bolts to line up the graduated latitude scale on the side of your mount to match your latitude.

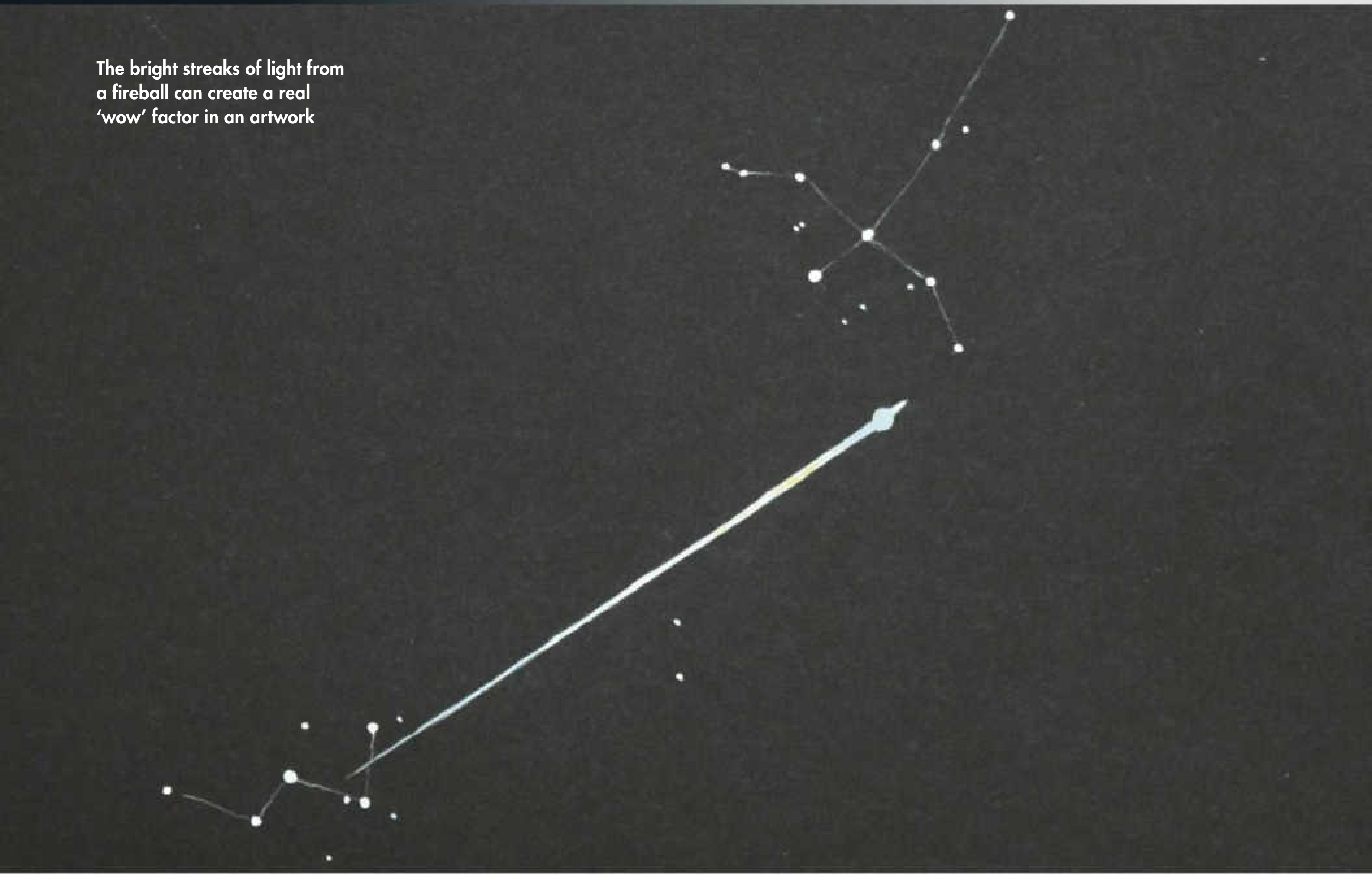
STEP 5

Adjust the RA axis, setting circles and date circles with the current date and time, using the process according to the type of mount that you have. Remember that each graduation on the date scale equals two days.



STEP 6

Adjust the altitude and azimuth bolts carefully, while looking through the polarscope, until Polaris fits perfectly in the little offset circle in the polarscope's reticule. Remember to undo each opposing bolt as you tighten. The mount is now polar aligned.



The bright streaks of light from a fireball can create a real 'wow' factor in an artwork

How to... SKETCH A FIREBALL

Ron Larter shows you how to make an artistic record of meteors' flaming colours

You've seen a meteor, or 'shooting star', but have you been lucky enough to glimpse a fireball? These very bright streaks of light always have that 'wow' factor. Meteors are the result of space debris, sometimes as small as a grain of sand, entering our atmosphere at high speed. This debris collides with particles in the atmosphere, exciting and ionizing them with energy that the atmospheric particles give off as light in a column perhaps 20-30km long. Here, we show you how to record your observation by drawing this incredible sight.

Fireballs are caused by substantial pieces of debris, up to a metre in length, which produce a much brighter streak of around magnitude -4.0 or greater. Although they're rare, you're more likely to see a fireball during a meteor shower, like the Orionids in October. These are certain times of the year when the Earth's track around the Sun takes it through paths of debris left by comets as they circle the Sun.

Fireballs can come in a variety of colours, ranging from red through to yellow, green, blue and blue-white. Colour is believed to be related to the composition of the debris, while the intensity of colour is attributed to its velocity. Some fireballs are even accompanied by audible explosions. Called 'bolides', these are normally caused by larger-mass meteoroids that can explode, the fragments causing further shock waves and creating a rumbling noise.

Although some are lucky enough to catch a photo or even a short video of a fireball, your camera probably won't be to hand. Even if it is, it's unlikely to be set up in the right direction. The thing to do is record it as a drawing, drawn from memory as soon after the event as possible. This may not be as accurate as a photo, but when coupled with accurate timings and intensity estimates, it can still furnish valuable information, and if done well, can certainly have artistic value too.

There are three basic artist's skills that will help you produce better fireball sketches: becoming familiar with the colour spectrum, recognising and using patterns, and judging relationships between one or more points.

Memory game

You probably know the colour spectrum's primary colours, but getting to know the intermediate shades will help you visually classify and remember a brief fireball streak when you witness it. It's also worth getting to know the different chromatic values of strong and weak colours for each shade, such as intense red or pale pinks.

Applying patterns to what we see aids memory when it comes to committing the

RON LARTER X 6, ISTOCK

TOOLS AND MATERIALS

ACRYLIC PAINT
Red, yellow, blue, green, orange and violet, plus white.

COMFORTABLE SEAT AND TABLE
Make sure they're set at the right height for you, to allow a steady hand when tracing the fireball.

DAYLIGHT BULB
Better to work by than a normal bulb.

SABLE BRUSHES
Sizes 1 and 2. Available from craft shops, these are excellent for details.

STAR CHARTS
To plot a fireball's path accurately.

WHITE PASTEL PENCIL
To mark the constellations and fireball trail. White pastel shows up well on black card, but can be easily erased if you need to make corrections.

fireball to paper. A key skill artists develop is to recognise underlying patterns in objects. In the night sky, the most obvious useful patterns are the constellations. If you're new to the stars, spend some time getting to know these shapes in the sky. Once they're embedded in the mind, they can be used as reference points to plot the direction and length of a fireball's streak, in a similar way to an artist using basic shapes to lay down detailed features.

Another useful skill to develop is your ability to make quick judgements on how one or more points relate to each other. To develop this visual ability, draw out some constellations on a large sheet of paper and put it on the floor. Then find a thin stick, drop it onto the paper and allow yourself only a few seconds to glance at its position in relation to the constellations. Turn away and sketch what you can remember as best you can.

Practising in this way will help you develop your visual memory so that, if you are lucky enough to witness a fireball event, you won't waste the vital moment scrabbling around in your bag for a camera. Instead, you'll be able to take in the bright sight in a relaxed manner, safe in the knowledge that you can faithfully recreate it on paper later.

STEP-BY-STEP GUIDE

Everything you'll need to start painting fireballs

STEP 1

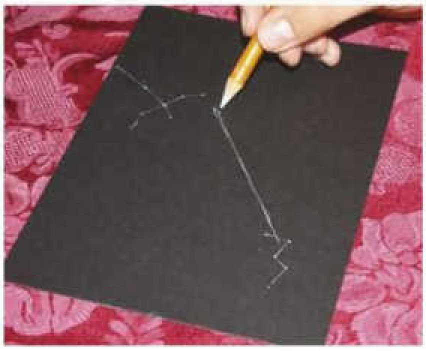
Get to know the time of year each meteor shower occurs, and where in the sky to look. Each shower is named after the constellation the meteors appear from – the Orionids from Orion, for example. If you see a fireball, fix its image and position in your memory.

STEP 2

If you can, make an on-the-spot sketch and jot down some notes. Aid your memory of the event by replaying it in your mind until you can get it down on paper. Recording a description on your mobile or other device also helps capture details.

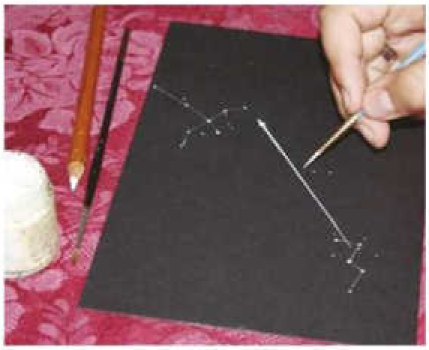
STEP 3

As with anything you try to remember, the longer you leave it, the vaguer your memory can become. So don't wait until the next day to get the event down on paper – as soon as you get indoors, get the materials you need together and make the sketch right away.



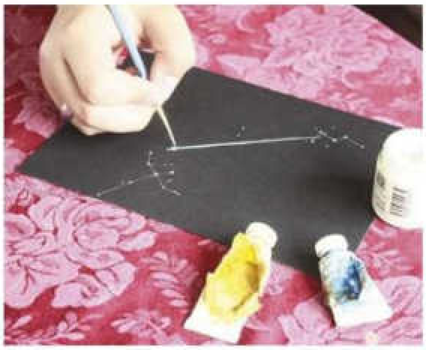
STEP 4

Cut a piece of black card to approximately 7.5cmx10cm in size, in readiness for your sketch. Make a light sketch of the appropriate constellations using a white pastel pencil; this can be easily rubbed out if you need to make corrections later.



STEP 5

Once you're happy that the background constellations are correctly placed, use white paint and a thin sable brush to dot the stars, making them permanent. When the paint is dry, lightly sketch in the fireball's length, size and position with a white pastel pencil.



STEP 6

Paint the pastel sketch with white paint thinned with water; this gives a light-toned base to place further colours on. When dry, add the colours of the fireball. Use flowing brush strokes for smooth features, or lightly dab the brush to stipple speckled features.

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Sky at Night MAGAZINE

Glossary

ALTAZIMUTH MOUNT

A type of telescope mount that's simpler to set up than an equatorial mount, but requires simultaneous movement about the vertical (altitude) and horizontal (azimuth) axes to track a celestial object.

AVERTED VISION

A technique for observing faint objects through a telescope. It involves viewing slightly to the side of the object, allowing its light to fall on an area of the eye more sensitive to light.

BARLOW LENS

A Barlow lens sits between a telescope's focuser and an eyepiece, and is used to increase the magnification of an eyepiece.

CATADIOPTRIC TELESCOPE

This is an optical system that uses both reflective and refractive elements. The Schmidt- and Maksutov-Cassegrain telescopes are both catadioptric designs, with a lens at the front and a mirror at the back of the scope.

CELESTIAL EQUATOR

A projection of the Earth's equator on to the night sky.

CELESTIAL SPHERE

This is the name given to the projection of the night sky on to an imaginary sphere around the Earth. The astronomical co-ordinates of right ascension and declination are also mapped on to this sphere.

COLLIMATION

The process of aligning the optical elements of a telescope.

DECLINATION

The celestial equivalent of latitude, this is the distance of a body north or south of the celestial equator, measured in degrees, minutes and seconds (°, ′ and ″). Objects north of the celestial equator have a positive declination, while those south of the celestial equator have negative declination.

ECLIPTIC

The apparent annual path of the Sun against the background stars.

ELONGATION

The angle in the sky between a planet and the Sun, as seen from Earth. When a planet is at greatest elongation (east or west), it is – from our perspective – at its farthest apparent distance from the Sun.

EQUATORIAL MOUNT

A telescope mount with an axis that's aligned parallel with the Earth's axis of rotation. This enables stars to be tracked as they drift across the sky by moving just one axis.

EYE RELIEF

The distance your eye has to be from an eyepiece for you to see the full field of view. People who wear glasses have to put their eye further away from the eyepiece and so need a longer eye relief.

FINDERSCOPE

The small, low-magnification telescope that is attached parallel to a main telescope tube. It's used to first locate celestial objects as it has a wider field of view than the main tube.

FOCAL LENGTH

The distance between a telescope's main lens or mirror and the point at which an image is brought into focus. You can work out magnification with this number, which is calculated by dividing the focal length of a telescope by that of an eyepiece.

MAGNITUDE

The brightness of an astronomical body. The lower the number, the brighter the object is. Magnitudes brighter than zero are represented with a negative number.

MERIDIAN

An imaginary line circling the Earth from north to south that marks the point at which the Sun is at its highest in the sky. Ante- and post-meridiem (am and pm) respectively mark the times before and after the Sun crosses the Meridian at midday.

NEWTONIAN TELESCOPE

A telescope that uses mirrors to collect and focus incoming light. A primary mirror collects the light, which is then intercepted by a smaller secondary mirror at an angle and reflected out of the side of the telescope to give a convenient viewing angle.

OPPOSITION

The position of a superior planet when it's opposite the Sun in the sky, as viewed from the Earth.

PLÖSSL EYEPIECE

A type of telescope eyepiece which provides a wide field of view and good eye relief, as typically there is a large distance between the lens and the exit pupil.

POLARSCOPE

A small scope that fits into equatorial mounts to help achieve an accurate polar alignment for your telescope. Accurate polar alignment is essential to take good quality, long-exposure images, where the star field needs to be tracked.

REFLECTING TELESCOPE

A telescope that collects and focuses light using mirrors.

RGB

A digital image records any colour as a combination of different intensities of red, green and blue.

RIGHT ASCENSION

The celestial equivalent of longitude, right ascension is measured in hours, minutes and seconds (h, m and s). The 0h line is measured from the point where the Sun crosses the celestial equator on its apparent path through the sky each year, a point called the vernal equinox.

SEEING

A measure of how steady Earth's atmosphere is. When the atmosphere is turbulent, views through a telescope tend to be blurrier; this is also the reason that stars appear to twinkle.

UNIVERSAL TIME (UT)

A timescale based on the rotation of the Earth on its axis, UT is measured from midnight at the Greenwich Meridian. In astronomical use UT replaced Greenwich Mean Time (GMT), which was measured from the Greenwich Meridian at midday, on 1 January 1925.

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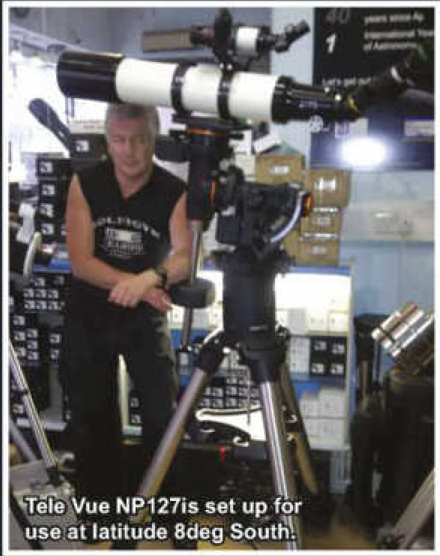

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News & Events 2016

2016 will be a great year for Astronomy! Check our website or App for details, or call us, drop into the store or catch us at one of the many events we will attend in 2016. Here are a few dates for your diary - some subject to confirmation, this list is far from complete:-

- Astrofest, London, Feb 5-6th
- Jupiter at Opposition Mar 8th
- Stargazing Live, Mar 19-21
- Solar Eclipse March 20th
- Equinox Star Party Apr 9th
- Astrocamp May 7-10th
- Mercury transit - May 9th
- Saturn Opposition May 22nd
- BSIA 6th birthday - June
- SW Astro Fair, August 6th
- Equinox Star Party Oct 1st
- Int'l.Astr.Show Oct 14-15th
- Kielder Star Camp Oct 29th

Additionally, the BSIA meets monthly, check for with us for details of forthcoming events!

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